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PERCHLORATE

Occurrence Is Widespread but at Varying Levels; Federal Agencies Have Taken Some Actions to Respond to and Lessen Releases

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Highlights

Highlights of GAO-10-769, a report to the Ranking Member, Committee on Environment and Public Works, U.S. Senate

PERCHLORATE

Occurrence Is Widespread but at Varying Levels; Federal Agencies Have Taken Some Actions to Respond to and Lessen Releases

Why GAO Did This Study

Perchlorate is both a man-made and naturally occurring chemical. It is used in rocket fuel, explosives, fireworks, and other products. Naturally occurring perchlorate is produced through atmospheric processes and then settles on surface water or land. Perchlorate can disrupt the uptake of iodide in the thyroid, potentially interfering with thyroid function and negatively affecting fetal and infant brain development and growth. As of June 2010, there is no federal regulatory standard for perchlorate in drinking water, and the Environmental Protection Agency (EPA), which has the authority to regulate contaminants in public drinking water systems, had not determined whether to establish one. The Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the Department of Energy (DOE) are the primary federal users of perchlorate.

GAO was asked to examine (1) what is known about the extent to which perchlorate occurs in the nation's water and food supply and its likely sources; (2) what actions DOD, NASA, and DOE have taken to respond to or lessen perchlorate releases; and (3) what actions states, such as California and Massachusetts, have taken to regulate perchlorate. To address these questions, GAO analyzed data from EPA, DOD, NASA, and DOE, reviewed agency documents, and interviewed federal and state officials, researchers, and others.

This report contains no recommendations.

View GAO-10-769 or key components.
For more information, contact John Stephenson at (202) 512-3841 or stephensonj@gao.gov.

What GAO Found

Perchlorate has been found in water and other media at varying levels in 45 states, as well as in the food supply, and comes from a variety of sources. EPA conducted one nationwide perchlorate sampling, between 2001 and 2005, and detected perchlorate at or above 4 parts per billion in 160 of the 3,865 public water systems tested (about 4.1 percent). In 31 of these 160 systems, perchlorate was found above 15 parts per billion, EPA's current interim health advisory level. Sampling by DOD, NASA, and DOE detected perchlorate in drinking water, groundwater, surface water, soil, and sediment at some facilities. For example, GAO's analysis of DOD data showed that perchlorate was detected at almost 70 percent of the 407 installations sampled from fiscal years 1997 through 2009, with detections ranging from less than 1 part per billion to 2.6 million parts per billion. A 2006 Food and Drug Administration study found perchlorate in 74 percent of 285 food items tested, with certain foods, such as tomatoes and spinach, having higher perchlorate levels than others. According to researchers, concentrations of perchlorate at or above 100 parts per billion generally result from activities involving man-made perchlorate, such as the use of perchlorate as a rocket propellant. Lower concentrations can result from the use of man-made perchlorate, atmospheric processes, or the use of fertilizer containing naturally occurring perchlorate.

According to DOD, NASA, and DOE officials, the agencies have sampled, monitored and, at several sites, begun cleaning up perchlorate. When DOD detects perchlorate at or above threshold levels—currently 15 parts per billion for water—DOD is to investigate further and may take additional actions. DOD has taken actions beyond initial sampling at 48 of the 53 installations with perchlorate detections above 15 parts per billion. NASA is in the midst of a cleanup at the Jet Propulsion Laboratory in California and is monitoring the level of perchlorate in groundwater at three other facilities. In addition, DOE is cleaning up perchlorate at two facilities involved in high explosives research, development, and testing and is monitoring the level of perchlorate in groundwater at two other facilities. According to DOD, NASA, and DOE officials, the perchlorate detected at their facilities is largely the result of past disposal practices. Officials at these agencies told us that by complying with current federal and state waste disposal laws and regulations, they have lessened their perchlorate releases. In addition, DOD is developing perchlorate substitutes for use in weapons simulators, flares, and rockets.

In the absence of a federal regulatory standard for perchlorate in drinking water, California and Massachusetts have adopted their own standards. California adopted a drinking water standard of 6 parts per billion in 2007, and Massachusetts set a drinking water standard of 2 parts per billion in 2006. The key benefits of a regulatory standard cited by state officials include protecting public health and facilitating cleanup enforcement. However, limited information exists on the actual costs of regulating perchlorate in these states. Also, at least 10 other states have established guidance levels for perchlorate in drinking water (ranging from 1 to 18 parts per billion) or in groundwater.

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Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOD	Department of Defense
DOE	Department of Energy
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
NASA	National Aeronautics and Space Administration
NRC	National Research Council
OEHHA	Office of Environmental Health Hazard Assessment
RCRA	Resource Conservation and Recovery Act
UCMR 1	Unregulated Contaminant Monitoring Rule 1

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United States Government Accountability Office
Washington, DC 20548

August 12, 2010

The Honorable James M. Inhofe
Ranking Member
Committee on Environment and Public Works
United States Senate

Dear Senator Inhofe:

Perchlorate is both a man-made and naturally occurring chemical. It is manufactured for use as an oxidizer[1] in solid rocket fuel, munitions, explosives, fireworks, road flares, and other products. It also occurs naturally and is found in certain fertilizers. Perchlorate can disrupt the uptake of iodide in the thyroid, potentially interfering with thyroid function and negatively affecting fetal and infant brain development and growth. Because of concerns over these and other potential health impacts, some states, water utilities, and Members of Congress have urged the U.S. Environmental Protection Agency (EPA) to set a federal drinking water standard for perchlorate. The Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the Department of Energy (DOE) are the primary federal users of perchlorate.

In response to your request for information on perchlorate, this report examines (1) what is known about the extent to which perchlorate occurs in the nation's water and food supply and its likely sources; (2) what actions DOD, NASA, and DOE have taken to respond to or lessen perchlorate releases; and (3) what actions states, such as California and Massachusetts, have taken to regulate perchlorate. To determine what is known about the extent of perchlorate occurrence in the nation's water and food supply and its likely sources, we analyzed perchlorate occurrence data provided by EPA, DOD, NASA, and DOE and interviewed federal and state agency officials, researchers, industry representatives, and others. To determine what actions DOD, NASA, and DOE have taken to respond to or lessen perchlorate releases, we analyzed agency data, reviewed agency documents, and interviewed agency officials and federal and state environmental officials. We visited selected DOD and NASA facilities to discuss and observe their activities related to perchlorate

[1]An oxidizer is a substance that yields oxygen readily to cause the combustion of other materials.

cleanup, including Edwards Air Force Base (DOD), Redstone Army Arsenal (DOD), the Jet Propulsion Laboratory (NASA),[2] and the Marshall Space Flight Center (NASA). We selected sites identified by EPA, DOD, and NASA officials as illustrative of their perchlorate response actions. To determine what actions California and Massachusetts have taken to regulate perchlorate, we reviewed state documents and interviewed state officials. In addition, we reviewed documents and interviewed officials in states that have set advisory levels and public health goals for perchlorate. We also interviewed EPA regional officials about state actions related to perchlorate.

We assessed the reliability of the DOD data that we used by electronically testing for obvious errors in accuracy and completeness, reviewing information about the data and the systems that produced them, and interviewing agency officials knowledgeable about the data. When we found inconsistencies in the data, we worked with DOD officials to clarify them before conducting our analyses. We also assessed the procedure used to collect the EPA data we used. We determined that both the DOD and EPA data were sufficiently reliable for the purposes of this report. We conducted our work from July 2009 to August 2010 in accordance with all sections of GAO's Quality Assurance Framework that are relevant to our objectives. The framework requires that we plan and perform the engagement to obtain sufficient and appropriate evidence to meet our stated objectives and to discuss any limitations in our work. We believe that the information and data obtained, and the analysis conducted, provide a reasonable basis for any findings and conclusions in this product. See appendix I for a more detailed description of our objectives, scope, and methodology.

Background

Man-made perchlorate is primarily produced as ammonium perchlorate for use as an oxidizer in solid rocket fuels, fireworks, explosives, and road flares. Perchlorate can also be present as an ingredient or as an impurity in such items as matches, lubricating oils, aluminum refining, rubber manufacturing, paint and enamel manufacturing, and leather tanning and as an ingredient in bleaching powder used for paper and pulp processing. Further, perchlorate can develop as a by-product of sodium hypochlorite (i.e., bleach) solutions used as disinfectant in water and wastewater

[2]The Jet Propulsion Laboratory is a federally funded research and development center managed by the California Institute of Technology for NASA.

treatment plants when these solutions are stored for a long period of time. Naturally occurring perchlorate is produced through atmospheric processes and then settles on surface water or land as precipitation or dry deposits. Perchlorate also exists as a natural impurity in nitrate salts from Chile, which are imported and used to produce nitrate fertilizers and other products.

EPA has the authority to regulate contaminants, such as perchlorate, in public drinking water systems. Under the Safe Drinking Water Act, as amended,[3] when EPA decides to regulate a contaminant, its determination must be based on findings that (1) the contaminant may have an adverse health effect, (2) the contaminant is known to occur or there is substantial likelihood that the contaminant will occur in public water systems with a frequency and at levels of public health concern, and (3) in the sole judgment of the Administrator, regulation of the contaminant presents a meaningful opportunity for reducing health risks for persons served by public water systems.

History of EPA's Investigation and Study of Perchlorate

Perchlorate was initially identified by EPA as a potential contaminant in 1985, when it was found in wells at hazardous waste sites in California. In 1992, EPA issued a provisional reference dose[4] for perchlorate equivalent to a concentration of 4 parts per billion in drinking water[5] and, in 1995, issued a revised provisional reference dose with a drinking water equivalent ranging from 4 to 18 parts per billion.[6] These reference doses were considered provisional by EPA because they had not undergone internal or external peer review. However, EPA and state regulators could use them to establish guidance levels for cleaning up contaminated groundwater. A more sensitive perchlorate detection method became

[3]Codified as amended at 42 U.S.C. § 300g-1(b)(1).

[4]EPA defines a reference dose as an estimate of a daily oral exposure for a given duration to the human population (including susceptible subgroups) that is likely to be without an appreciable risk of deleterious health effects during a lifetime. Reference doses are generally expressed as milligrams per kilogram of body weight per day.

[5]EPA calculates the drinking water equivalent level—expressed in parts per billion—assuming that an adult weighing 70 kilograms (or 154 pounds) consumes 2 liters of water per day, and all perchlorate exposure comes from drinking water.

[6]EPA determined that there was too much scientific uncertainty to establish a provisional reference dose as a single point and, therefore, established a range.

available in 1997, and more states began detecting perchlorate in drinking water, groundwater, and surface water.

In 1998, EPA published its first draft assessment of perchlorate exposure health risks and placed perchlorate on its Contaminant Candidate List—a list of contaminants that may require regulation under the Safe Drinking Water Act. In 1999, under Unregulated Contaminant Monitoring Rule 1 (UCMR 1), EPA required all public drinking water systems serving more than 10,000 people and 800 representative public water systems serving 10,000 or fewer people to monitor their drinking water systems for perchlorate over a 12-month period and to report the results.[7] Also, in 1999, an external panel of independent scientists reviewed EPA's draft risk assessment and recommended additional studies and analyses to provide more data on perchlorate and its health effects. DOD and industry researchers conducted such studies and submitted them to EPA. Based on an analysis of these studies, EPA revised its draft perchlorate risk assessment and released it for peer review and public comment in January 2002. The revised draft risk assessment included a proposed reference dose equivalent to a concentration of 1 part per billion in drinking water. DOD, industry, and some members of the scientific community disagreed with EPA's draft risk assessment and its conclusions, including the proposed reference dose. The scientific controversy involved, among other things, the adequacy and relevance of available human data for assessing health risks, the quality and validity of some animal data, the definition of adverse health effect, and the application of uncertainty factors.

After a second peer review, and in light of the criticisms from some scientists surrounding the concentration at which perchlorate presents a human health risk, DOD, NASA, DOE, and EPA asked the National Academy of Sciences, in 2003, to review the available science and EPA's draft health risk assessment. In January 2005, the Academy's National Research Council (NRC) recommended a reference dose for perchlorate exposure of 0.0007 milligrams per kilogram of body weight per day.[8] EPA calculated the drinking water equivalent of this dose to be 24.5 parts per billion. EPA adopted the reference dose and, in January 2006, directed its

[7]The 800 small public water systems represented about 1 percent of the approximately 67,000 systems serving 10,000 or fewer people from which the sample was drawn.

[8]National Research Council, *Health Implications of Perchlorate Ingestion* (Washington, DC.: 2005).

regional offices to use 24.5 parts per billion as a preliminary remediation goal[9] when assessing sites for cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980[10] and the National Oil and Hazardous Substances Pollution Contingency Plan, the regulation that implements CERCLA.

In October 2008, EPA issued a preliminary determination not to regulate perchlorate and requested public comment on its findings that perchlorate occurs infrequently at levels of health concern in public water systems and that there was not a "meaningful opportunity for health risk reduction" through a national drinking water regulation. In response to stakeholder comments that provided additional scientific evaluation of the information EPA used to make its preliminary determination, EPA announced, in January 2009, that it planned to seek additional input from NRC on assumptions regarding the possible effects of perchlorate on infants and young children. Around the same time, EPA's Office of Water published an interim health advisory for perchlorate that includes a health advisory level of 15 parts per billion. This interim health advisory level takes into account exposure from food, as well as drinking water, for pregnant women and their fetuses (the most sensitive life stage identified by NRC). The advisory provides informal technical guidance to assist state and local officials in protecting public health where perchlorate contamination of drinking water has occurred, while EPA evaluates the opportunity to reduce risks through a national drinking water standard. Following the establishment of the interim health advisory, EPA's Office of Solid Waste and Emergency Response withdrew its preliminary remediation goal for perchlorate of 24.5 parts per billion. In its place, EPA recommended the interim health advisory level of 15 parts per billion be used as the preliminary remediation goal when assessing sites for cleanup under CERCLA.

In August 2009, EPA published a notice that it would not seek additional input from NRC and instead was seeking public comment on additional approaches for interpreting the available data on the level of health

[9]A preliminary remediation goal is a chemical-specific concentration goal for a specific medium (e.g., soil, sediment, and water) that serves as a target to use during the initial development, analysis, and selection of cleanup alternatives.

[10]Pub. L. No. 96-510 (1980), codified as amended at 42 U.S.C. § 9601 et seq. (2010). CERCLA, better known as Superfund, provides EPA with certain oversight authority for cleaning up releases of hazardous substances, pollutants, or contaminants on federal and private properties.

concern, the frequency of occurrence of perchlorate in drinking water, and the opportunity for health risk reduction through a national drinking water standard. In April 2010, EPA's Office of Inspector General released a report that reviewed and critiqued the risk assessment process and procedures used by EPA to develop and derive the perchlorate reference dose.[11] As of July 2010, EPA had not yet made a final decision whether to establish a regulatory standard for perchlorate in drinking water.

Requirements for Federal Agencies Related to Perchlorate

Several federal laws impose requirements on federal agencies related to monitoring, reporting, and cleanup of hazardous substances, pollutants, and contaminants such as perchlorate.

- CERCLA, as amended, better known as Superfund, requires responsible federal agencies to identify and assess releases of hazardous substances such as perchlorate[12] and to follow CERCLA requirements in their cleanup, among other things. The CERCLA process typically follows a series of steps, which may include investigations, human health risk assessments and ecological risk assessments, evaluation and selection of cleanup approaches, and implementation of the cleanup, known as a remedial action.

- CERCLA itself does not establish cleanup standards. Rather, the remedial action chosen by a federal agency must meet applicable or relevant and appropriate requirements based on standards for contaminants set under state or federal laws or regulations and in consideration of other guidance.[13] If there is no such requirement for a given contaminant, the agency must still achieve a degree of cleanup, which, at a minimum,

[11]EPA, *Office of Inspector General Scientific Analysis of Perchlorate*, Report No. 10-P-0101 (Washington, D.C.: Apr. 19, 2010).

[12]One federal court has ruled that perchlorate contaminating a site was a hazardous substance under CERCLA. *Castaic Lake Water Agency v. Whittaker Corp*, 272 F. Supp. 2d 1053 (C.D. Cal. 2003). The court held that perchlorate is a hazardous waste under the Resource Conservation and Recovery Act and, as the definition of hazardous substances under CERCLA includes hazardous waste under the Resource Conservation and Recovery Act, perchlorate is therefore a hazardous substance under CERCLA.

[13]State guidance levels may be used to determine remediation goals in the context of a CERCLA cleanup. See 40 C.F.R. § 300.430(e)(2)(i) (2010).

assures protection of human health and the environment. Both existing and potential sources of drinking water are generally to be considered in assessing risk and in selecting a remedy.[14]

- In general, EPA is the lead regulator for all sites on EPA's list of some of the most contaminated sites in the country—the National Priorities List—which are commonly referred to as Superfund sites. State environmental agencies may be the lead regulator at other sites.

- Executive Order 12580 delegated certain CERCLA response authorities to federal agencies.[15] In particular, DOD and DOE each have lead response agency authority for properties under their respective jurisdictions, which they are to exercise consistent with CERCLA section 120 governing federal facilities.

- The Superfund Amendments and Reauthorization Act established the Defense Environmental Restoration Program in 1986 and directs DOD to clean up releases of hazardous substances, such as perchlorate, at active DOD installations and formerly used defense sites in accordance with CERCLA.[16]

- The Resource Conservation and Recovery Act (RCRA), as amended, requires federal agencies generating, treating, or disposing of hazardous wastes, including hazardous wastes containing perchlorate, to obtain permits and/or to comply with regulations applicable to the management of such wastes.[17]

- Pursuant to its responsibilities under the Safe Drinking Water Act, in 1999, EPA promulgated the UCMR 1, which required entities, including federal

[14]CERCLA applies federal drinking water standards to potential sources to the same extent as to existing sources of drinking water when establishing site cleanup requirements. While there is currently no such federal drinking water standard for perchlorate, this provision indicates the general intent to protect potential water supplies, as well as present ones. In addition, some states have established water quality standards for groundwater whether or not it is currently used as a drinking water source, often reflecting state positions that most groundwater is considered potential drinking water. For example, New Jersey has established a standard of 5 parts per billion for perchlorate in groundwater classified as an existing or potential drinking water source; this standard is generally applicable to groundwater cleanups.

[15]Executive Order 12580, 52 Fed. Reg. 2923 (Jan. 23, 1987).

[16]Superfund Amendments and Reauthorization Act, § 211, 10 U.S.C. §§ 2701-07 (2010).

[17]42 U.S.C. §§ 6901-6992k (2010).

agencies, operating large and selected small public water supplies to monitor their drinking water systems for perchlorate and other contaminants over a 1-year period and to report the results.[18]

- The Clean Water Act requires federal agencies discharging pollutants into surface waters—such as from a wastewater treatment facility—to obtain a National Pollutant Discharge Elimination System permit from EPA and comply with its discharge limitations.[19]

- Pursuant to RCRA and the Safe Drinking Water Act, EPA can issue perchlorate abatement orders to federal facilities where there is an imminent and substantial endangerment to health and other conditions are met.

Since 2002, DOD has issued a series of perchlorate policies. Most recently, in April 2009, DOD issued a policy on perchlorate release management that directs the military services to, among other things, address perchlorate in the same manner that the services address other contaminants of concern. The policy adopts EPA's preliminary remediation goal for perchlorate of 15 parts per billion in water where (1) there is an actual or potential drinking water exposure pathway[20] and (2) no legally applicable or relevant and appropriate requirements exist under federal or state laws. NASA and DOE have issued no policies that focus exclusively on perchlorate, according to agency officials.

[18]42 U.S.C. §§ 300f-300j-26 (2010).

[19]33 U.S.C. §§ 1251-1387 (2010).

[20]According to EPA, primary pathways for human exposure to perchlorate are ingestion of food and contaminated drinking water.

Perchlorate Occurs Nationwide at Varying Levels, and the Sources Are Sometimes Difficult to Determine

The full extent of perchlorate occurrence is unknown because there is no national system to track detections. However, perchlorate has been found at varying levels across the nation in water and the food supply and is known to come from a variety of sources. While the sources of perchlorate at or above 100 parts per billion in the environment are generally the result of defense-related or manufacturing activities, sources of concentrations below that level can be difficult to determine.

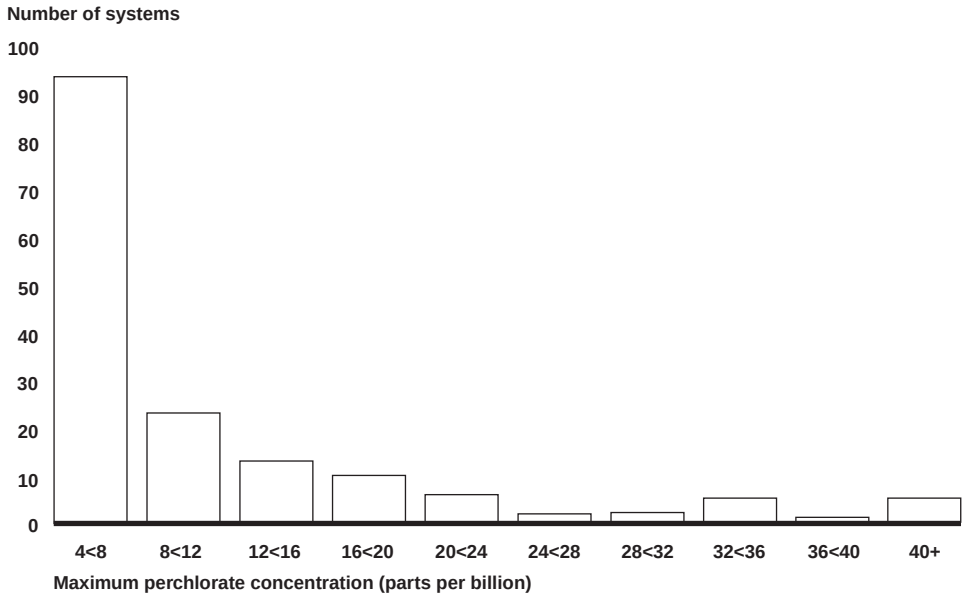
Although the Full Extent of Perchlorate Occurrence Is Unknown, It Has Been Detected at Varying Levels in Drinking Water and Other Media in 45 States

There is no national system to track perchlorate detections, so the full extent of perchlorate occurrence nationwide is unknown. In 2005, we recommended that EPA establish a formal structure to centrally track and monitor perchlorate detections.[21] EPA officials disagreed with our recommendation, saying that the agency already had sufficient information on perchlorate concentrations in various environmental media that indicated the extent of contamination nationally and that if EPA were to implement a tracking system, the agency would require additional resources. However, as our report noted, without a formal system to track and monitor perchlorate findings and cleanup activities, EPA and the states do not have the most current and complete accounting of perchlorate as an emerging contaminant of concern, including the extent of perchlorate found and the extent or effectiveness of cleanup projects.

Although there has been no nationwide sampling for perchlorate recently, nationwide sampling under EPA's UCMR 1, which occurred between 2001 and 2005, detected perchlorate at or above 4 parts per billion in at least one sample in approximately 4.1 percent of the public drinking water systems tested. According to EPA data, perchlorate was reported in 160 of 3,865 public drinking water systems, with detections ranging from 4 to 420 parts per billion. Thirty-one of the 160 systems, or about a fifth, had detections above 15 parts per billion—EPA's current interim drinking water health advisory level. Figure 1 shows the number of public water systems with perchlorate detections and the maximum concentration detected, according to EPA's data.

[21]See GAO, *Perchlorate: A System to Track Sampling and Cleanup Results Is Needed*, GAO-05-462 (Washington, D.C.: May 20, 2005).

Figure 1: UCMR 1 Public Drinking Water Systems with Perchlorate Detections, 2001-2005



Source: GAO analysis of EPA data.

EPA and U.S. Geological Survey officials and other researchers told us that technology is now available to detect perchlorate at levels below 1 part per billion, while the analytical method used under UCMR 1 had a minimum detection level of 4 parts per billion.

Sampling conducted at various times by federal agencies, including DOD, NASA, DOE, and EPA, has detected perchlorate in drinking water, groundwater, surface water, soil, and sediment.[22] Specifically,

- DOD reported perchlorate detections at 284 of its installations, or almost 70 percent of the 407 installations sampled from fiscal years 1997 through 2009, with detections ranging from less than 1 part per billion to 2.6 million parts per billion. Maximum detection in parts per billion included 30 in drinking water, 230 in sediment, 6,600 in surface water, 786,000 in soil, and 2,600,000 in groundwater. Fifty-three of the 284 installations, or about 20 percent, reported perchlorate concentrations above 15 parts per billion, DOD's current screening threshold for initiating additional site investigation when perchlorate is detected in water. According to DOD,

[22]As used here, "sediment" means matter that settles to the bottom of water.

the agency generally uses perchlorate in munitions and missiles, and its releases of perchlorate occurred primarily at maintenance facilities, rocket testing sites, and waste disposal areas.

- NASA found perchlorate at four of the seven facilities where it sampled for the chemical from fiscal years 1997 through 2009. According to NASA, the agency began to look for perchlorate at its facilities across the country after a more sensitive method of perchlorate detection became available in the late 1990s and in response to requests from federal and state regulators. NASA reported the highest detection of 13,300 parts per billion in groundwater in 2002 at the Jet Propulsion Laboratory in California. At the Marshall Space Flight Center in Alabama, perchlorate detections from 2000 through 2008 fell at or below 4.4 parts per billion in groundwater. According to NASA, at the Stennis Space Center in Mississippi, in 2003, the agency detected perchlorate concentrations ranging from 3.7 to 12,639 parts per billion in groundwater. At the White Sands Test Facility in New Mexico, perchlorate detections from 2006 through 2009 fell at or below 2.6 parts per billion in groundwater. At the Jet Propulsion Laboratory, NASA attributed perchlorate contamination to the disposal of perchlorate waste in underground pits during the 1940s and 1950s. According to NASA, perchlorate contamination at Stennis is associated with munitions testing.

- DOE detected perchlorate at the five facilities where it sampled for the chemical in fiscal years 1998 through 2009—Lawrence Livermore National Laboratory Site 300 in California, Los Alamos National Laboratory in New Mexico, the Pantex Plant in Texas, Sandia National Laboratories in New Mexico, and the Energy Technology Engineering Center at the Santa Susana Field Laboratory in California.[23] Detections occurred in groundwater or soil and ranged from less than 1 part per billon to 3,090 parts per billion. DOE reported the highest concentrations (3,090 parts per billion) in perched groundwater at the Pantex Plant.[24] According to DOE, perchlorate contamination resulted from historical waste management practices and testing of high explosives.

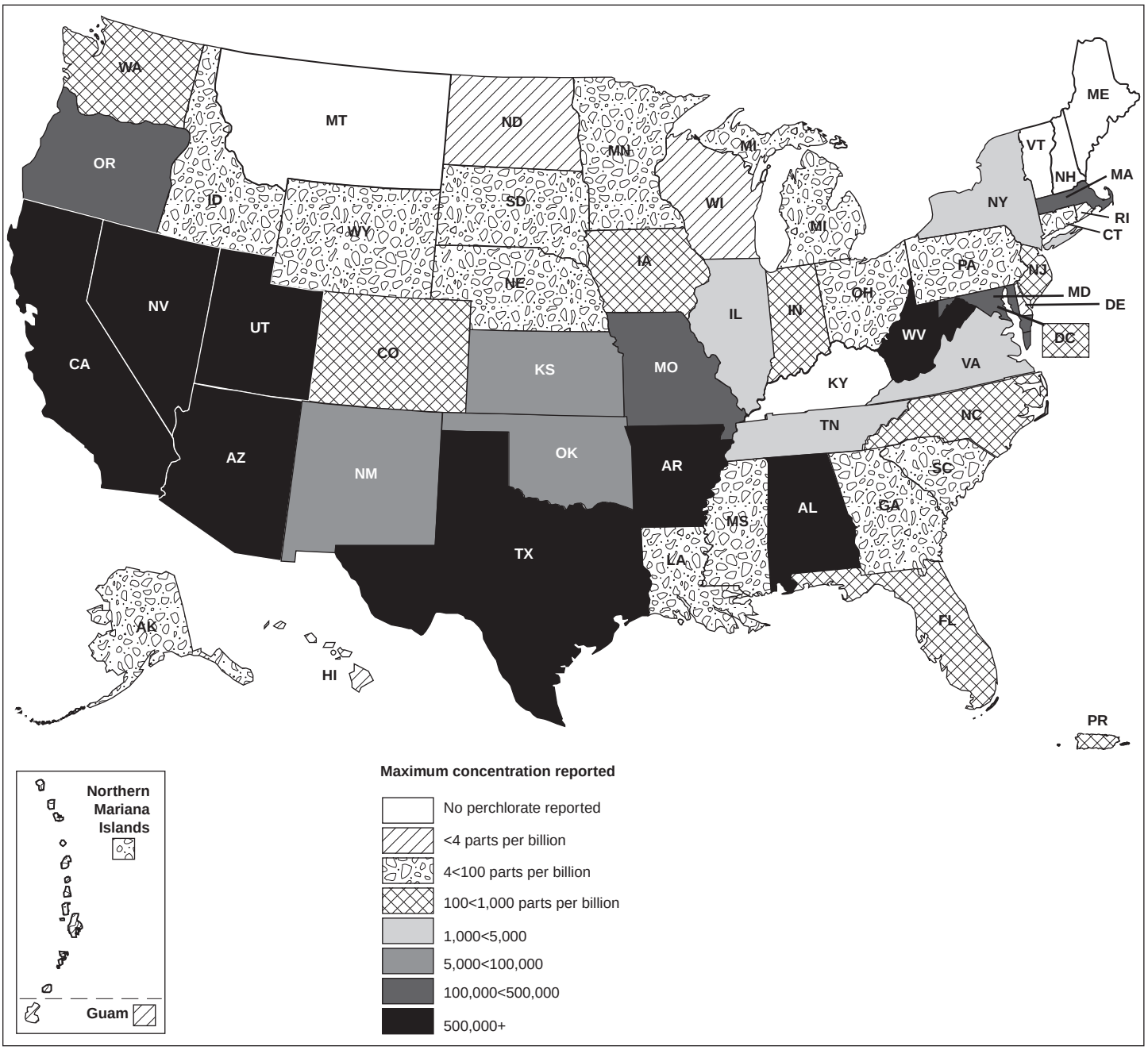
[23]The Santa Susana Field Laboratory site is divided into four areas that are under different ownership. Boeing owns part of Area I, and all of Areas III and IV. NASA owns Area II and owns 42 acres of Area I. From 1956 to 1988, the Energy Technology Engineering Center, which is located in Area IV, was used by Rocketdyne and DOE for nuclear energy research and development. The Energy Technology Engineering Center is now closed.

[24]Perched groundwater is groundwater that sits above a main body of groundwater and is separated by a layer of geologic material (such as clay, silts, or shale) that acts as a barrier to downward flow.

- As of June 2010, EPA reported perchlorate detections at 40 sites on the National Priorities List. In addition to 25 sites maintained by DOD, NASA, DOE, and the U.S. Department of the Interior, there were 15 private sites. At private sites, the highest perchlorate levels ranged from 13 to 682,000 parts per billion in groundwater. See appendix II for a list of National Priorities List sites where perchlorate has been identified as a contaminant of concern.

  Overall, considering detections reported by EPA and DOD, as shown in figure 2, perchlorate has been detected in 45 states, the District of Columbia, and three U.S. territories.

Figure 2: Maximum Perchlorate Concentrations Reported in Any Media as of October 2009



Sources: EPA and DOD; Map Resources (map).

Two states, California and Massachusetts, mandate that public water systems sample for perchlorate to ensure that public drinking water supplies in their states comply with state drinking water standards (6 parts per billion in California and 2 parts per billion in Massachusetts). Although initial testing of drinking water systems found some levels of perchlorate contamination, testing undertaken in fiscal year 2009 found no drinking water systems that violated the standard in either state, according to state officials. In California, according to state officials, they also track perchlorate in groundwater because 40 percent of the state's drinking water supply comes from groundwater. California officials told us that perchlorate occurrence is widespread in the state, with Southern California having more detections at higher levels in groundwater than other parts of the state. According to California officials, this perchlorate came from a variety of sources including defense activities and Chilean fertilizer. In Massachusetts, perchlorate levels at or above 2 parts per billion have been found in only a few locations in groundwater and in one surface water supply, according to state officials. However, many other groundwater supplies have detected perchlorate at levels that are less than 2 parts per billion.

Additionally, research conducted in Arizona and northwest Texas detected relatively low levels of perchlorate. In a 2004 report, the Arizona Department of Environmental Quality, among others, assessed the extent of perchlorate occurrence in the state's water sources, including the Colorado River, which is known to be contaminated with perchlorate from a chemical plant near Henderson, Nevada.[25] The study found that, while perchlorate is present in certain areas of the state, the concentrations in bodies of water not associated with industrial sites were generally at levels well below 14 parts per billion, which was Arizona's health-based guidance level for perchlorate at the time.[26] Also in 2004, Texas Tech University reported on the source and distribution of perchlorate in northwest Texas groundwater.[27] The study found widespread perchlorate occurrences at

[25]Arizona Department of Environmental Quality, *Perchlorate in Arizona: Occurrence Study of 2004* (2004).

[26]A health-based guidance level reflects the maximum concentration of a contaminant in drinking water that that is unlikely to result in adverse health effects during long-term exposure. Arizona reduced its health based guidance level for perchlorate to 11 parts per billion in 2005 after EPA revised its reference dose.

[27]W. Andrew Jackson et al., *Distribution and Potential Sources of Perchlorate in the High Plains Region of Texas* (August 2004).

very low concentrations and concluded that they were likely the result of natural processes and not caused by human activities.

From 2005 to 2007, the U.S. Geological Survey published several studies in collaboration with other researchers investigating naturally occurring perchlorate in groundwater, surface water, and soils in the United States.[28] In addition, a 2009 U.S. Geological Survey study found perchlorate from Chilean fertilizer in Long Island, New York, and concluded that other areas in the United States that used Chilean fertilizer in the late nineteenth century through the twentieth century may also contain perchlorate.[29] In addition to the key studies cited above, smaller-scale studies have also been conducted.

Food and Drug Administration and Other Researchers Have Found Perchlorate in a Variety of Foods at Low Concentrations

In addition to finding perchlorate in water and soil, Food and Drug Administration (FDA) and other researchers have found perchlorate in a variety of foods. Existing research suggests several ways that perchlorate may enter the food supply, such as the use of perchlorate contaminated water in agriculture. The most comprehensive study of perchlorate in food—FDA's 2006 Total Diet Study[30]—found perchlorate in 74 percent of the 285 food items tested across the country.[31] These food items represent the major components of the American diet, such as dairy, meat, fruits, and vegetables. Certain foods, such as tomatoes and spinach, had higher perchlorate levels than others. Using the analytical results for the food samples collected, FDA researchers calculated and reported the estimated average perchlorate intake from food for the total U.S. population and 14

[28]J.K. Böhlke et al., "Perchlorate isotope forensics," *Analytical Chemistry*, vol. 77, no. 23 (2005); L.N. Plummer, J.K. Böhlke, and M.W. Doughten, "Perchlorate in Pleistocene and Holocene groundwater in North-Central New Mexico," *Environmental Science and Technology*, vol. 40, no. 6 (2006); and N.C. Sturchio et al., "Oxygen and chlorine isotopic fractionation during perchlorate biodegradation: laboratory results and implications for forensics and natural attenuation studies," *Environmental Science and Technology*, vol. 41, no. 8 2007).

[29]J.K. Böhlke et al., "Atacama Perchlorate as an Agricultural Contaminant in Groundwater: Isotopic and Chronologic Evidence from Long Island, New York," *Environmental Science and Technology*, vol. 43, no. 15 (2009).

[30]For more information on FDA's Total Diet Study, see http://www.fda.gov/Food/FoodSafety/FoodContaminantsAdulteration/TotalDietStudy/default.htm.

[31]In each of four geographic regions of the United States (West, North Central, South, and Northeast), FDA took samples of each of 285 food items and, for 211 of those items, found perchlorate in at least one of the samples.

age and gender subgroups.[32] Estimated average perchlorate intake from each food item varied by age and gender, but the average total consumption of perchlorate for all groups was below the 2005 NRC-recommended reference dose for perchlorate exposure of 0.0007 milligrams per kilogram of body weight per day. The highest level of average perchlorate consumption was reported for children 2 years of age, with an estimated consumption ranging from 0.00035 to 0.00039 milligrams per kilogram of body weight per day. According to the study, the average level of perchlorate consumption for these children was higher because they consume more food per their body weight, and they have different food consumption patterns—with over half of their perchlorate intake coming from dairy foods. According to an FDA official, in 2008, FDA conducted another round of Total Diet Study sampling and is in the process of compiling the data, though the FDA official we spoke with does not expect results to be published until later in 2010 or 2011.

Other studies and researchers have found that certain foods are more likely than others to contain perchlorate. For example, a 2009 study by researchers at the Centers for Disease Control and Prevention found perchlorate in all types of powdered infant formula, with higher concentrations in milk-based formula.[33] Similarly, a 2008 study on foods produced in the lower Colorado River region reported perchlorate in milk and various fruits and vegetables, including lettuce, but researchers concluded that few individuals would be exposed to perchlorate levels exceeding EPA's reference dose.[34] According to researchers we contacted, only one study has attempted to quantify the contribution of various sources of perchlorate to the food supply. A 2006 study concluded that Chilean fertilizer and man-made perchlorate are the main and comparable contributors to the perchlorate found in the food supply, while naturally

[32]Clarence W. Murray et al., "U.S. Food and Drug Administration's Total Diet Study: Dietary intake of perchlorate and iodine," *Journal of Exposure Science and Environmental Epidemiology*, vol. 18 (2008).

[33]Joshua G. Schier et al., "Perchlorate exposure from infant formula and comparisons with the perchlorate reference dose," *Journal of Exposure Science and Environmental Epidemiology*, vol. 1-7 (2009).

[34]Charles A. Sanchez et al., "Perchlorate exposure from food crops produced in the lower Colorado River region," *Journal of Exposure Science and Environmental Epidemiology*, vol. 1-10 (2008).

occurring perchlorate is a lesser source.[35] Finally, researchers we spoke with said that more studies are needed to better understand the extent to which perchlorate exists in the food supply.

While the Likely Sources of Some Perchlorate Detections Are Known, Sources of Others Can Be Difficult to Determine

According to the perchlorate researchers we spoke with, concentrations of perchlorate at or above 100 parts per billion are generally the result of activities involving man-made perchlorate, such as the use of perchlorate in manufacturing or as a solid rocket propellant. Researchers we contacted told us that perchlorate detected at levels above 100 parts per billion is generally man-made and is limited to a specific area. Further, EPA, DOD, California, and Massachusetts officials told us they have generally been able to determine the likely sources of localized high concentrations of perchlorate, such as those detected at certain Superfund sites.

Concentrations of perchlorate below 100 parts per billion can result from the use of man-made perchlorate, natural processes, or the use of fertilizer containing naturally occurring perchlorate. Researchers we spoke with said that naturally occurring perchlorate formed atmospherically is typically found in water or soil at 1 part per billion or less, while perchlorate found in water or soil due to Chilean fertilizer can vary in concentration ranges but generally is not found at levels greater than 30 parts per billion. Levels of perchlorate below 100 parts per billion can also be attributed to various activities, including localized uses, such as fireworks and road flares, which release perchlorate that is typically diluted over a short time period, researchers said.[36]

The sources of concentrations of perchlorate below 100 parts per billion found around the country are often difficult to determine when there are no records of historic use or when there is more than one potential source. According to researchers we spoke with, current technology can often differentiate between man-made and naturally occurring perchlorate, but it cannot yet differentiate among different sources of man-made perchlorate. DOD has funded the development of this technology, which

[35]P.K. Dasgupta et al., "Perchlorate in the United States: Analysis of Relative Source Contributions to the Food Chain," *Environmental Science and Technology*, vol. 40, no. 21 (2006).

[36]Richard T. Wilkin et al., "Perchlorate Behavior in a Municipal Lake Following Fireworks Displays," *Environmental Science and Technology*, vol. 41, no. 11 (2007).

identifies the isotopic signature or fingerprint of a perchlorate sample and compares the signature with known sources of perchlorate.[37] According to researchers we contacted, because man-made perchlorate and naturally occurring perchlorate have different isotopic signatures, researchers can distinguish between them. However, the technology is not widely used to identify sources of perchlorate because it is expensive, and there is no EPA- or state-certified identification method available. Therefore, federal and state officials told us that they rely mainly on historical records to identify sources of perchlorate. For example, officials identify sites where they believe perchlorate was used and gather site-specific documentation to ascertain perchlorate sources.

In the case of CERCLA sites, EPA officials said that they do not focus on identifying perchlorate sources. Rather, they attempt to identify the potentially responsible party for responding to the contamination, such as current or former owners and operators of a site. CERCLA explicitly identifies four types of parties that can be held responsible, including (1) owners or operators of a site; (2) former owners or operators of the site at the time hazardous substances were disposed of; (3) those who arranged for disposal or treatment of hazardous substances (often called generators); and (4) transporters of hazardous waste.[38] According to EPA, the agency identifies responsible parties by, among other actions, reviewing documentation related to the site; conducting interviews with government officials or other knowledgeable parties; performing historical research on the site, such as searching for previous owners of the property; sampling soil or groundwater at the site; and requesting additional information from relevant parties.

[37]An isotopic signature is the distribution of certain chemical elements and their respective ratio of isotopes in a chemical compound.

[38]The statute also provides exemptions from liability for parties meeting certain characteristics, as well as statutory defenses.

DOD, NASA, and DOE Have Sampled for Perchlorate, Begun Cleanup Actions at Some Sites, and Taken Steps to Lessen Releases

DOD, NASA, and DOE have sampled for perchlorate at a number of their facilities and have begun cleanup actions at some sites. According to DOD, DOE, and NASA officials, by complying with current federal and state waste disposal laws and regulations, they have lessened perchlorate releases. Further, DOD and DOE have taken additional actions to lessen perchlorate releases such as DOD's development of perchlorate substitutes.

DOD, NASA, and DOE Have Sampled for and, at Some Sites, Cleaned Up Perchlorate

DOD officials told us that the military services are to sample for perchlorate at their installations wherever there is a release or suspected release and follow the same CERCLA procedures as for other contaminants. In general, to determine whether to sample for perchlorate at an installation, DOD installations rely on historical records and knowledge of perchlorate use, DOD officials said. According to our analysis of DOD data from fiscal year 1997 through fiscal year 2009, DOD sampled for perchlorate at 407 installations. Of the 361 installations that reported not sampling, the primary reason cited for not sampling was that there was no history, record, or indication of perchlorate use, according to our analysis of DOD data. In addition, beginning in 2005, DOD began requiring the military services to identify and evaluate the extent to which the use of military munitions on operational ranges has resulted in the potential for munitions constituents, including perchlorate, to migrate off-range and create unacceptable risk to human health and the environment.[39] In 2004, DOD collaborated with the state of California and finalized a procedure for prioritizing perchlorate sampling at DOD facilities in California, known as the California Prioritization Protocol.[40] Through this procedure, DOD and California screened 924 DOD sites that had the potential for perchlorate releases and concluded that the majority

[39]In 2005, DOD established the operational range assessment program to implement procedures to assess the potential environmental impacts of military munitions use on operational ranges. An operational range is an area that is currently in service and is regularly being used for weapons training using live ammunition or such a range that is not currently being used but that is still considered by the military to be a potential range area.

[40]The procedure included steps to identify and prioritize the investigation of areas on DOD installations and formerly used defense sites (1) where the presence of perchlorate is likely based on previous and current defense-related activities and (2) near drinking water sources where perchlorate was found.

of potential perchlorate releases associated with DOD sites had already been identified through existing environmental programs and were being addressed.[41] Additionally, DOD and California officials agreed that, based on the results of the prioritization, the current regulatory standards for perchlorate, sampling results to date, as well as actions taken by DOD to manage new releases and remediate known perchlorate releases, it appears that DOD's installations and formerly used defense sites are not significantly impacting California public drinking water wells.[42]

According to DOD's current perchlorate policy, when detections in water equal or exceed an identified threshold level—currently EPA's health advisory level of 15 parts per billion or a stricter state standard if identified by DOD—DOD is to conduct further investigations to determine whether additional action is warranted.[43] Decisions as to whether to take further action are generally made at the military service's installation level. According to Army, Air Force, and Navy officials, the actions taken at installations may include conducting additional sampling, identifying the contaminated media, characterizing the extent of contamination, and adding perchlorate to the installation's list of contaminants of concern.[44]

Our analysis of data from DOD's perchlorate database showed that military service officials had decided to take action beyond initial sampling at 48 of the 53 installations with perchlorate detections above 15 parts per billion. (See app. III.) Redstone Arsenal in Alabama and Edwards Air Force Base in California illustrate some of the actions taken by the Army and the Air Force beyond sampling to address perchlorate.

[41]The protocol excluded RCRA sites, DOD operational ranges, sites greater than 5 miles from a public drinking water well, releases that impact media other than drinking water wells, and non-DOD sites, including contractor-owned facilities.

[42]For more information on the California Prioritization Protocol, see Laurie Racca et al., *Attention to Protocol: How a State/Federal Partnership Defused Tensions over Perchlorate*, EM Magazine (December 2008).

[43]DOD has used various threshold levels at different times in the past, reflecting EPA's reference doses. At sites that have undergone remediation followed by 5-year reviews, DOD may review perchlorate concentrations to determine if they exceed current thresholds. However, at sites where DOD made a determination that no further action is required, based on thresholds in use at the time, DOD has not necessarily conducted subsequent reviews of the site's perchlorate concentrations when the thresholds for action have been lowered.

[44]Each installation conducting cleanup activities is required to have a management action plan to guide environmental restoration, which is to contain this list, among other things.

- Redstone Arsenal. In 2000, the Army found perchlorate in groundwater and soil at sites associated with rocket motor production. Between 2005 and 2009, the Army conducted an investigation of groundwater to characterize the nature of the contamination and examined potential treatment options, including ion exchange.[45] According to DOD officials, the Army has identified and planned a number of actions to remove contaminated soils that serve as an on-going source of perchlorate to groundwater. The Army is drafting a memorandum of understanding with the city of Huntsville whereby the city will consult with the Army before approving any well installation requests for areas with the potential for perchlorate contamination. However, according to EPA officials, because DOD has not signed an interagency agreement for Redstone, EPA has no legal mechanism to ensure that the Army formally coordinates with adjacent government entities to limit exposure to off-site wells that may be contaminated.[46] Finally, according to DOD officials, the Army is in the process of obtaining regulatory approval from EPA for further site investigation on some perchlorate contaminated areas, which could determine the need for and feasibility of remedial action.

- Edwards Air Force Base. In 1997 and 1998, the Air Force found perchlorate in groundwater at two locations associated with solid rocket propellant testing, including the North Base and the Air Force Research Laboratory. The Air Force attributes contamination at North Base to past NASA Jet Propulsion Laboratory activities at the site. However, as site owner, the Air Force has taken responsibility for responding to the release. According to Air Force officials, at North Base, the groundwater plume has stayed on the base and has not contaminated drinking water supplies. In 2003, the Air Force began operating an ion exchange system to treat perchlorate in groundwater. By 2009, the Air Force had reduced the level detected from 30,700 to 3,700 parts per billion. The Air Force also removed 50 pounds of perchlorate from the soil and reduced the level detected from 110,000 to 300 parts per billion in 2007. At the Air Force

[45]Ion exchange treats perchlorate by using resins that attract perchlorate and exchange their ions to break down the perchlorate. According to federal officials and researchers we contacted, ion exchange is the preferred technology to remediate drinking water and other media at low concentrations. Another treatment option is bioremediation, which uses bacteria to break down perchlorate to a component of table salt. It is used to treat high concentrations of perchlorate.

[46]We have recently found that Redstone Arsenal is one of the four long-standing DOD installations on the National Priorities List for which DOD has not signed an Interagency Agreement, even though it is required under CERCLA. See GAO, *Superfund: Interagency Agreements and Improved Project Management Needed to Achieve Cleanup Progress at Key Defense Installations*, GAO-10-348 (Washington, D.C.: Jul. 15, 2010).

Research Laboratory sites, according to Air Force officials, the Air Force found it impractical to take remedial action because the perchlorate-contaminated groundwater was trapped in bedrock from 20 to over 200 feet below the earth's surface and would be extremely costly to remove. Furthermore, according to Air Force officials, it would take over 1,000 years to remediate perchlorate at the sites. EPA officials we spoke with agreed that no solution existed to clean up this perchlorate. According to Air Force officials, EPA and state regulators have agreed with the Air Force's decision not to clean up the sites. In addition, to treat perchlorate in soil, the Air Force has removed 10 cubic yards of contaminated soil and rock at one research laboratory site and has contracted for the removal of an additional 40 cubic yards of contaminated soil.

EPA and state regulatory officials told us that the actions DOD takes to respond to perchlorate contamination vary, depending on the military service, installation, and personnel involved. For example, EPA officials told us that staff at Edwards Air Force Base proactively took steps to address perchlorate contamination at the base. According to Air Force officials, personnel at Edwards began investigating perchlorate occurrence in 1997. At the time, DOD had no perchlorate policy. In addition, according to EPA officials, DOD had not approved funding to treat perchlorate at Edwards, so personnel at Edwards convinced DOD to fund research on perchlorate treatment technologies at Edwards that were eventually used to remediate perchlorate at the base. In contrast, according to a New Mexico state official, for several years, the Air Force had not taken steps to remediate perchlorate at Kirtland Air Force Base despite requirements to do so under state law implementing RCRA. According to DOD officials, there is disagreement over whether further actions at Kirtland should be conducted under CERCLA pursuant to DOD's perchlorate policy or under the state's RCRA authority. According to state and DOD officials, the Air Force submitted a site investigation work plan in 2010 to address perchlorate releases, and Air Force officials told us that they have begun investigating the site.

In addition to sampling for and, in some cases, cleaning up perchlorate, DOD has provided funding for research and development of perchlorate treatment technologies.[47] This work, among other things, is funded mainly through two programs—the Strategic Environmental Research and

[47]According to DOD officials, some of this funding has been directed by Congress or congressional committees, while some has been voluntary.

Development Program and the Environmental Security Technology Certification Program.[48] From fiscal years 1998 through 2009, DOD spent at least $84 million researching and developing perchlorate treatment technologies, according to a DOD official. According to DOD, the development and use of innovative environmental technologies support the long-term sustainability of DOD's training and testing ranges, as well as significantly reduce current and future environmental liabilities. The programs help DOD identify better ways to treat contaminants, including perchlorate, a DOD official said. For example, several DOD installations with perchlorate detections obtained funds for pilot treatment projects from DOD and used the systems they developed to clean up perchlorate.

According to NASA officials, the agency has detected perchlorate at four of the seven facilities where sampling occurred based on the historical use of perchlorate. NASA has undertaken a major perchlorate cleanup effort at one facility—the Jet Propulsion Laboratory in Pasadena, California, where NASA detected a groundwater plume that had contaminated local drinking water supplies. To respond to the release, NASA took several actions. To clean up perchlorate in groundwater at the Jet Propulsion Laboratory, NASA installed a biological fluidized bed reactor—a system that uses bacteria to treat perchlorate. To clean up perchlorate in groundwater in Altadena, California, a neighboring community, NASA installed an ion exchange system, which began operating in 2004. In addition, NASA is currently working with the city of Pasadena to construct a groundwater treatment system. According to NASA officials, all the groundwater treatment systems will need to operate for at least 18 years to clean up the perchlorate plume and, as of 2009, the systems had been operational for 5 years. As of 2010, perchlorate groundwater detections are about 150 parts per billion in the source area of contamination, compared with 13,300 parts per billion detected in 2002, according to NASA officials.

NASA is monitoring perchlorate at the other three facilities where it has found perchlorate in groundwater—the Marshall Space Flight Center in Alabama, the Stennis Space Center in Mississippi, and the White Sands Test Facility in New Mexico. From 2003 to 2008, perchlorate detections at Marshall ranged up to 4.4 parts per billion at the monitoring well with the

[48]According to DOD, the Strategic Environmental Research and Development Program is DOD's environmental science and technology program and is conducted in partnership with DOE and EPA, while the Environmental Security Technology Certification Program promotes innovative, cost-effective environmental technologies through demonstration and validation at DOD sites.

highest detections. NASA is determining what actions may be needed at Stennis, where perchlorate detections ranged up to 40,700 parts per billion at the monitoring well with the highest detections in 2005. According to NASA officials, perchlorate contamination at Stennis is associated with past DOD activities, such as munitions tests conducted more than 30 years ago. Both NASA and DOD officials told us that they are currently discussing the agency responsibilities for responding to perchlorate releases. According to a NASA official, the agency is monitoring perchlorate at White Sands as directed by the state of New Mexico and generally detections fall below 1 part per billion. In addition to monitoring at Marshall, Stennis, and White Sands, NASA officials said, for the past 25 years, the agency has conducted environmental monitoring after space launches at the Kennedy Space Center in Florida, but it has detected no perchlorate.

Finally, according to DOE officials, the agency has sampled and detected perchlorate at all five facilities where there was a potential for contamination based on the use of the chemical in high explosives research, development, and testing. DOE has taken a variety of actions at these five facilities.

- At the Pantex Plant in Texas, in 1999, DOE detected perchlorate at 408 parts per billion in perched groundwater that sits above the regional drinking water aquifer[49] and, in 2007, after installing additional monitoring wells, the agency detected perchlorate in the perched groundwater at concentrations up to 1,070 parts per billion, DOE officials said. In June 2009, DOE detected perchlorate as high as 3,090 parts per billion in the perched groundwater, DOE officials told us.[50] With the approval of EPA and the state of Texas, DOE is using bioremediation to clean up perchlorate in the perched groundwater to 26 parts per billion and has put restrictions in place to prevent the use of perched groundwater without treatment.

[49]An aquifer is an underground bed or layer of permeable rock, sediment, or soil that yields water.

[50]According to DOE officials, in 2007, DOE installed two monitoring wells in anticipation of installing a groundwater treatment system and encountered higher levels of perchlorate than it originally detected in 1999. Subsequently, DOE installed injection wells for the treatment system downstream from the monitoring wells and encountered concentrations of perchlorate up to 3,090 parts per billion.

- At Lawrence Livermore National Laboratory Site 300 in California, DOE first detected perchlorate in groundwater in 1998. The highest historical detection was 92 parts per billion in 2008. DOE agreed with EPA and the state of California in 2008 to clean up perchlorate to 6 parts per billion, the state's drinking water standard. DOE is treating perchlorate using ion exchange and had reduced the highest level detected to 69 parts per billion in 2009, according to agency officials. Further, DOE is planning to study whether bioremediation can also be used to clean up the perchlorate-contaminated groundwater.

- At Los Alamos National Laboratory in New Mexico, DOE detected perchlorate in groundwater wells in the late 1990s. According to DOE officials, in general, current perchlorate concentrations in groundwater are less than 10 parts per billion, but detections range from 80 to 130 parts per billion in a group of deep wells that monitor a perched groundwater zone above the water supply aquifer. DOE is continuing to monitor the levels of perchlorate in groundwater, according to agency officials.

- At Sandia National Laboratories, also in New Mexico, between 2000 and 2009, DOE sampled for perchlorate in groundwater. Detections were at levels less than 15 parts per billion except in one well, where the highest detection in 2006 was 1,260 parts per billion. However, according to DOE officials, the Air Force sampled the well recently and detected perchlorate at only 2.7 parts per billion.[51] In 2001, DOE detected perchlorate in soil ranging from 16.7 to 1,040 parts per billion. According to DOE officials, the state of New Mexico is currently requiring DOE to continue to monitor the levels of perchlorate in groundwater at Sandia and evaluate the need for further action.

- At the Energy Technology Engineering Center at the Santa Susanna Field Laboratory in California, in 2000, DOE detected perchlorate in groundwater at 18 parts per billion, in soil at 3,600 parts per billion, and in sediment at 6 parts per billion, DOE officials said. According to DOE officials, the agency is planning additional sampling at new sites.

[51]According to DOE officials, the highest concentrations of perchlorate in groundwater were found at the Explosive Ordnance Disposal Hill Well, which is shared with Kirtland Air Force Base, and the state of New Mexico is requiring the Air Force to conduct further investigation of perchlorate at the site.

Improved Waste Disposal Practices and Research May Lessen Perchlorate Releases

DOD, DOE, and NASA officials we contacted agreed that perchlorate contamination at their facilities was generally caused by waste disposal practices that were commonly used before the enactment of key environmental laws, such as RCRA. Historically, these practices included, among others, disposing of perchlorate waste in open pits, open burning and detonation of perchlorate, and using water to remove perchlorate residue from rocket engines, which contributed to contamination in groundwater. DOD, DOE, and NASA officials told us that their current practices for perchlorate use and disposal follow current federal and state environmental laws and regulations and, by doing so, lessen perchlorate releases. For example, DOD officials told us that whereas historically certain munitions were burned or detonated in open sites, they are now handled in contained areas and burned on steel pads subject to requirements for the management and disposal of the waste. Furthermore, according to Air Force officials, perchlorate is now removed using a dry process that seals the perchlorate before it is burned rather than a wet process that allowed it to contact the ground and potentially contaminate groundwater. In addition, at DOE's Lawrence Livermore National Lab Site 300, to reduce the amount of contaminants in general, including ammonium perchlorate, all but one of the outside firing tables—areas outside the laboratory used to test high explosives—that could release contaminants to the environment have been closed, according to DOE officials. According to NASA officials, NASA believes that there is no contamination caused by current perchlorate use during space shuttle launches, because rapid combustion consumes virtually all of the perchlorate during the first two minutes of flight and sampling around rocket launch complexes, such as the Kennedy Space Flight Center, has detected no perchlorate.

In addition to lessening perchlorate releases, from fiscal years 1999 through 2009, DOD spent at least $26 million developing perchlorate substitutes, according to a DOD official.[52] For example, in 1999, DOD's Army Research, Development and Engineering Command began developing perchlorate substitutes for use in weapons simulators, flares, and rockets, according to DOD officials. Regarding weapons simulators, DOD researchers have developed perchlorate substitutes for training simulator hand grenades and artillery shells for use on Army training ranges, and DOD officials estimated that production of these simulators will begin in early 2011. DOD officials estimated that the use of the new

[52]According to DOD, all funding for perchlorate substitutes has been voluntary.

weapons simulators should reduce potential perchlorate use on Army training ranges by 35 to 70 percent. Additionally, DOD is conducting research on ways to recycle perchlorate removed from discontinued military munitions.

In the Absence of a Federal Standard, Some States Have Set Drinking Water Standards and Guidance Levels for Perchlorate

In the absence of a federal regulatory standard for perchlorate in drinking water, California and Massachusetts have adopted their own standards. In addition, at least 10 other states have established guidance levels for perchlorate in various media.

California's and Massachusetts' Actions to Set Regulatory Standards for Perchlorate and Information on the Associated Benefits and Costs

California and Massachusetts have taken a variety of actions leading to establishing state regulatory standards for perchlorate. California promulgated its drinking water standard for perchlorate of 6 parts per billion in 2007, and Massachusetts set a drinking water standard of 2 parts per billion in 2006. Each state has also identified some of the benefits and costs of setting these standards.

California's Actions

California first identified perchlorate as an unregulated contaminant requiring monitoring in January 1997 after the chemical was found in drinking water wells near Aerojet, a rocket manufacturer in Sacramento County that had used ammonium perchlorate as a solid rocket propellant. Subsequent monitoring that year by the California Department of Public Health[53] found perchlorate in dozens of drinking water wells near Aerojet and in southern California, principally in the counties of Los Angeles, Riverside, and San Bernardino. State level testing also found perchlorate in Colorado River water, an important source of drinking water and agricultural irrigation water for southern California.

[53]The California Department of Public Health was formerly the California Department of Health Services. For purposes of this report, we will use the department's current name.

In 1997, in response to the detections of perchlorate in drinking water, the California Department of Public Health set an action level[54] of 18 parts per billion based on the high end of EPA's 1995 provisional reference dose range, which had a drinking water equivalent of 4 to 18 parts per billion. In 1999, the department added perchlorate to the list of unregulated contaminants that public water systems were required to monitor. In January 2002, when EPA released a revised draft reference dose for perchlorate that corresponded to 1 part per billion in drinking water, the California Department of Public Health lowered its action level to 4 parts per billion, the lower end of EPA's 1995 provisional reference dose range of values, and the lowest level that the analytical method in use at the time could reliably measure.[55] Also in 2002, California enacted a law requiring the Office of Environmental Health Hazard Assessment (OEHHA) to establish a public health goal and the Department of Public Health to establish a state drinking water standard for perchlorate.

Under state law, before the Department of Public Health establishes a standard, OEHHA must assess the contaminant's risks to public health. OEHHA's risk assessment is required to contain "an estimate of the level of the contaminant in drinking water that is not anticipated to cause or contribute to adverse health effects, or that does not pose any significant risk to health."[56] This level is called a public health goal. To calculate the public health goal, OEHHA used data from the 2002 Greer study on the effects of perchlorate on healthy adults,[57] the same study used by the NRC in its 2005 report, applied an uncertainty factor of 10 to protect pregnant women and infants, and assumed that 60 percent of perchlorate exposure comes from water to arrive at a proposed public health goal of 6 parts per billion. According to OEHHA, the draft public health goal for perchlorate was more extensively reviewed than any of the other public health goals that OEHHA has developed. The draft technical support document for the

[54]An action level—now called a notification level—is the level at which public water companies must report the presence of a contaminant to the Department of Public Health. The department may recommend that utilities take steps to remove the water source from service if average contaminant levels exceed between 10 times to 100 times the action level, depending on the chemical.

[55]U.S. EPA Method 314.0.

[56]California Health and Safety Code, section 116365(c).

[57]M.A. Greer et al., "Health Effects Assessment for Environmental Perchlorate Contamination: The Dose Response for Inhibition of Thyroidal Radioiodine Uptake in Humans," *Environmental Health Perspectives*, vol.110, no. 9 (2002).

proposed public health goal was reviewed twice by University of California scientists.[58] EPA also peer reviewed the document. In addition, OEHHA held two public comment periods and a public workshop on the draft document. In March 2004, OEHHA established a public health goal for perchlorate in drinking water of 6 parts per billion. In its technical support document, OEHHA made a commitment to review the NRC report assessing the potential adverse health effects of perchlorate upon its completion and, if necessary, revise the public health goal. When NRC released its report in January 2005,[59] OEHHA reviewed the report and determined that the findings were consistent with and supported the approach that OEHHA used to develop its public health goal.

By law, the California Department of Public Health is required to set a drinking water standard as close to the public health goal as is economically and technologically feasible. To determine whether the standard for perchlorate should be proposed at the public health goal level of 6 parts per billion, the Department of Public Health evaluated the feasibility of standards at different levels in terms of available analytical methods for detecting perchlorate, monitoring costs, available treatment technologies for removal to the proposed maximum contaminant level, and the estimated fiscal impact on California drinking water utilities to comply with the proposed standard. The department estimated that the total annual costs to public water systems of a drinking water standard at 6 parts per billion would be about $23.9 million a year and that the total population avoiding exposure would be 518,600, whereas the total annual cost at 10 parts per billion would be an estimated $8.7 million with about 188,360 people avoiding exposure. The department noted that while the cost impacts of a standard above 10 parts per billion would be minimal, very little public health benefit would be achieved. To further evaluate the feasibility, the department estimated that the annual costs for larger systems that exceeded the drinking water standard would be $18 per customer, while annual costs for smaller systems would be $300 to $1,580 per customer. Because of this difference, the department proposed to

[58]OEHHA's normal process calls for one round of peer review by the university. However, Lockheed Martin and Kerr McGee had filed a lawsuit against OEHHA over whether the two firms could request and obtain a second peer review of OEHHA's draft review document. The judge ruled that procedural requirements in state law required OEHHA to accept the firms' request and issued a court order requiring OEHHA to finalize the public health goal within 60 days of the completion of the second peer review.

[59]National Research Council, *Health Implications of Perchlorate Ingestion* (Washington, D.C.: 2005).

provide variances for smaller systems based on affordability criteria. Based on that analysis, the department promulgated a regulatory drinking water standard for perchlorate of 6 parts per billion, which became effective in October 2007. Now that a standard has been established, California public drinking water systems must monitor to ensure that the drinking water they distribute complies with this standard. Should a system exceed the standard, it must notify the Department of Public Health and the public and take steps to immediately come back into compliance. Systems in noncompliance may face fines or permit suspension or revocation, among other possible enforcement measures. California Department of Health officials told us that public water systems that exceed the standard generally treat the contaminated water or turn off the contaminated well.

In addition to setting a regulatory standard for drinking water, California adopted best management practice regulations for handling materials, products, and waste that contain perchlorate. For example, those who manufacture, package, distribute, receive, or generate certain materials containing perchlorate must ensure they are properly contained in water-resistant packaging and labeled, and nonhazardous perchlorate waste[60] must be disposed of in a hazardous waste landfill or a composite-lined portion of a nonhazardous landfill.[61] These regulations, which were adopted in December 2005, and became effective in July 2006, apply to any person or business that manages—such as by using, processing, generating, transporting, storing, or disposing—perchlorate materials or waste, with certain exceptions.[62]

Massachusetts' Actions

In 2001, perchlorate was detected in groundwater at the Massachusetts Military Reservation at 600 parts per billion and, in 2002, in monitoring wells upstream from drinking water wells in the adjacent town of Bourne at concentrations less than 1 part per billion. The Bourne Water District shut three municipal wells when perchlorate was detected at levels less

[60]According to EPA officials, perchlorate that no longer displays the characteristic of ignitability is treated as nonhazardous waste.

[61]In a composite-lined portion of a nonhazardous landfill, a flexible synthetic membrane is used to line the bottom and sides of the landfill to protect groundwater and underlying soil from contamination.

[62]For example, certain perchlorate-containing materials, such as consumer products and irrigation water, are excluded from these regulations, as is any perchlorate-containing material that is being managed in accordance with hazardous waste rules or in a cleanup under oversight of a regulatory agency. Cal. Code Regs. tit. 22, § 67384.2-3 (2010).

than 1 part per billion and, in March 2002 formally requested guidance from the Massachusetts Department of Environmental Protection on the health significance of perchlorate in drinking water. Based on a review of available information on the toxicity of perchlorate, including EPA's 2002 draft health assessment for perchlorate and draft reference dose with a drinking water limit equivalent to 1 part per billion, the department recommended that the water district notify sensitive subgroups, such as pregnant women, should perchlorate concentrations exceed 1 part per billion and advise them to avoid consuming the water.

In 2003, the Massachusetts Department of Environmental Protection convened an external science advisory committee to evaluate the peer-reviewed studies on perchlorate. Given the limited number of such studies on perchlorate and its effect on sensitive populations, in February 2004, the department established a drinking water health advisory level for perchlorate of 1 part per billion consistent with EPA's January 2002 draft perchlorate health assessment. According to state environmental officials, Massachusetts adopted an advisory level at 1 part per billion to protect sensitive populations, specifically, pregnant women and their fetuses, infants, children up to 12 years of age, and people with thyroid conditions. In March 2004, Massachusetts initiated the process for setting a drinking water standard by issuing emergency regulations requiring most public water supply systems to test for perchlorate. Perchlorate was found in 9 of 600 systems tested, with perchlorate detections ranging from just below 1 part per billion to 1,300 parts per billion.[63] Next, to assess the health risks of perchlorate exposure, department toxicologists and an external science advisory committee reviewed scientific studies, including the 2005 NRC perchlorate study,[64] as well as other information that had recently become available, such as a 2005 study on perchlorate in breast milk[65] and data

[63]None of the nine water supplies appeared to have any connection to military activities. Instead, perchlorate contamination was associated with the launching of fireworks and the use of flares, certain blasting agents, and hypochlorite solutions to disinfect drinking water. Perchlorate was also found to be discharged from an industrial source at extremely high levels.

[64]National Research Council, *Health Implications of Perchlorate Ingestion* (Washington, D.C.: 2005).

[65]Andrea B. Kirk et al., "Perchlorate and Iodide in Dairy and Breast Milk," *Environ. Sci. Technol.*, vol. 39, no. 7 (2005).

made available by FDA on perchlorate in food.[66] To calculate a reference dose for perchlorate, Massachusetts used the lowest-observed-adverse-effect level[67] from the Greer study[68] as the point of departure. Given the limited sample size of the study (i.e., 37 subjects), Massachusetts used a larger uncertainty factor (100) than applied by the NRC (10) to be more protective of infants and pregnant women and their fetuses, and to allow for data gaps. The department also assumed a 20 percent exposure from drinking water to take into account the various other potential sources and exposure pathways of perchlorate (i.e., food), especially for infants and pregnant women, which resulted in a reference dose for perchlorate with a drinking water equivalent level less than 1 part per billion.

To arrive at a drinking water standard, the department considered information on the availability and feasibility of testing and treatment technologies, as well as data that demonstrated that perchlorate can enter drinking water as a by-product of hypochlorite (e.g., bleach) solutions used as disinfectants in water treatment plants. The department chose to set the standard at a level that does not create any disincentive for public water systems to disinfect their water supplies. The department determined that a maximum contaminant level of 2 parts per billion would provide the best overall protection of public health, considering the benefits of disinfection, while retaining a margin of safety to account for uncertainties in the available data. In July 2006, Massachusetts became the first state to set a drinking water standard for perchlorate. At the same time, Massachusetts set cleanup standards for perchlorate, including a 2 parts per billion cleanup standard for groundwater that could be classified for drinking water.

In addition to setting a regulatory standard for perchlorate, Massachusetts has also taken action to minimize potential problems associated with perchlorate by issuing best management practices guidance for blasting operations and for fireworks displays. Also, Massachusetts officials reported that they are working with EPA to develop guidance for the use of hypochlorite solutions in water treatment plants.

[66]For more information, see http://www.fda.gov/Food/FoodSafety/FoodContaminantsAdulteration/ChemicalContaminants/Perchlorate/ucm077685.htm.

[67]The lowest-observed-adverse-effect level is the lowest dose in a toxicity study resulting in adverse health effects.

[68]M.A. Greer et al., "Health Effects Assessment."

Information on the Benefits and Costs of Setting a Regulatory Standard for Perchlorate in California and Massachusetts

While California and Massachusetts estimated the costs and benefits of setting standards for perchlorate as part of their regulatory processes, neither state has conducted a comprehensive analysis of the actual costs and benefits of their perchlorate regulations. However, according to California officials, setting a regulatory standard for perchlorate has benefited public health. Massachusetts officials also cited protecting public health, particularly children's health, as a key benefit, and added that cleaning up water supplies can also decrease the levels of perchlorate in food. However, while both states estimated the benefits in terms of the reduction in the number of people who would be exposed to perchlorate, they did not attempt to quantify the dollar value of these benefits. In addition, officials from both states told us that having a regulatory standard allows the state and public water utilities to identify polluters and hold them accountable for remediation. In particular, California officials told us that adopting a perchlorate regulation ended DOD's reluctance to take action in response to perchlorate releases. Massachusetts officials reported that adopting a standard provided the impetus for the military to conduct perchlorate cleanup. Further, Massachusetts officials said that having a standard provides a simple and less costly means for determining whether remediation is necessary, as well as when no further remedial response action is necessary.

Officials from both states said that their regulatory programs had costs to the state. While California officials acknowledged that there were administrative costs associated with developing its drinking water standard, they did not have data on those costs. EPA regional officials also cited the loss of water resources when contaminated wells were taken out of service as a cost to the state and noted that additional costs may be incurred to clean up the water should the state have to put some of these wells back into service because of drought conditions. Massachusetts reported that the process used to establish a drinking water standard cost the state approximately $1.35 million, or the equivalent of about 9 staff years. However, additional costs for monitoring and cleanup have been minimal because the number of public water systems with perchlorate detections above the level of concern has been small.

Officials from both states said that their perchlorate regulation also had costs to public water systems, including initial and ongoing monitoring costs, capital and construction costs to install treatment facilities, and operations and maintenance costs.

- *Initial and ongoing monitoring costs.* California state officials estimated that to sample for perchlorate costs an average of $88 per sample, while

Massachusetts state officials estimated an average of $125 per sample. The number of samples taken will vary by public water system and whether sampling shows that the system is out of compliance with the state's drinking water standard. While each state estimated that monitoring costs would be higher initially because all public systems would be required to sample for perchlorate, officials from each state reported that most public water systems are compliant and now only need to conduct annual monitoring.

- *Capital and construction costs to install treatment facilities.* In general, determining the capital cost of a treatment facility, such as a blending station,[69] an ion exchange facility, or a biological fluidized bed reactor, will depend on the individual site, according to California officials. Some of the factors that can play a role in the cost include the concentration of perchlorate, evidence of other contaminants, the need to purchase additional land, and construction costs. According to officials from each state, ion exchange is the technology generally used for treating perchlorate in drinking water, although California has also identified biological fluidized bed reactors as a cost-effective technology. Ion exchange systems have relatively low capital costs and are simpler to operate compared with biological fluidized bed reactors, which have higher capital costs and take up more space, according to officials at Aerojet.

- *Operations and maintenance costs*. Operations and maintenance costs will vary by type of treatment facility, water quality, and system flow rate. California officials noted that an ion exchange system is more expensive to operate than a fluidized bed reactor because of the cost of replacing the resin to which perchlorate molecules adhere as water passes through the system. When the resin becomes saturated with perchlorate, it must be replaced and disposed of as waste. In comparison, a fluidized bed reactor creates no waste disposal problem. Treatment costs for an ion exchange system can run about $165 to $185 per acre foot of water, whereas treatment costs for a fluidized bed reactor can run about $35 to $65 per acre foot, according to officials at Aerojet. California officials told us that the high operating costs of ion exchange can cause financial problems for small water systems. For this reason, California allows a water system serving less than 10,000 persons to apply to the department for a variance from the perchlorate drinking water standard if water system officials can demonstrate that the estimated annualized cost per household for

[69]Some public water systems will use a blending station to mix perchlorate-impacted water with clean water to achieve regulatory compliance with drinking water standards.

treatment to comply exceeds 1 percent of the median household income in the community within which the customers served by the water system reside.

Several States Have Issued Guidance Levels for Perchlorate

In addition to the regulatory standards set by California and Massachusetts, at least 10 states have established for various purposes guidance levels for perchlorate ranging from 1 part per billion to 18 parts per billion for drinking water and from 1 part per billion to 72 parts per billion for groundwater.[70] Depending on the state, a particular level may trigger public notice, serve as a screening tool for further action, or guide cleanup action, among other things.

Table 1 provides a listing of state guidance levels for perchlorate in drinking water.

Table 1: Summary of State Guidance Levels for Perchlorate in Drinking Water

Level in parts per billion		
State	**Level**	**Description**
Arizona	11	Health-based guidance level
Kansas	4	Drinking water threshold level used as default protective level for all drinking water (including private wells)
Maryland	1	Advisory level
New York	5	Action step triggering notification to state
	18	Action step triggering state-recommended action to reduce concentration
Texas	4	Interim action level
Vermont	4	Guideline

Sources: EPA and state environmental agencies.

Table 2 provides a listing of state guidance levels for perchlorate in groundwater.

[70]EPA does not maintain an up-to-date list of states that have adopted guidance levels for perchlorate. However, we were able to obtain information on state actions from EPA regional officials and the Association of State Drinking Water Administrators, which we then verified with state environmental officials.

Table 2: Summary of State Guidance Levels for Perchlorate in Groundwater

Level in parts per billion		
State	**Level**	**Description**
Florida	4	Cleanup target level for potable water[a]
	40	Cleanup target level for groundwater of low yield or poor quality[a]
Illinois	4.9	Nonregulatory health advisory used for potable water, including potential water supplies, and as default value for groundwater cleanup objectives
Kansas	11	Default risk-based cleanup level for residential or drinking water pathway (based on established equations and current EPA reference dose)
	72	Default risk-based cleanup level for nonresidential pathway (based on established equations and current EPA reference dose)
Nevada	18	Provisional action level used as default cleanup level for all groundwater
New Jersey	5	Interim specific criterion used as default remediation standard
Texas	17	Protective cleanup level for residential land use
	51	Protective cleanup level for industrial/commercial land use
Vermont	2	Interim preventive action level
	4	Interim enforcement standard[b]

Sources: EPA and state environmental agencies.

Note: A default value is a value used in the absence of a site-specific risk assessment.

[a]This level, established in regulation, is not a standard but serves as a default level for contaminated site cleanups. Alternative levels may be used where there is sufficient site-specific information.

[b]This level is considered guidance, despite its being termed a "standard."

In addition, two states—Illinois and Wisconsin—have proposed regulatory standards for perchlorate in groundwater. Finally, New Jersey proposed a drinking water standard of 5 parts per billion in 2009, but the state's newly appointed Commissioner of the Department of Environmental Protection decided in March 2010 to delay adopting a standard until EPA made its regulatory determination, and New Jersey's proposed rule has lapsed.

Agency Comments and Our Evaluation

We provided a draft copy of this report to DOD, DOE, EPA, and NASA for review and comment. We received a written response from the Assistant Deputy Under Secretary of Defense (Installations and Environment). DOD believes that the report omitted a number of important facts and conclusions, including the major conclusions of the California Prioritization Protocol, the sources of perchlorate in Massachusetts, the amount of perchlorate imported primarily for fireworks compared with the amount of perchlorate used by DOD, information on the health risks of perchlorate, and the conclusions of the EPA Office of Inspector General's

report regarding perchlorate health risks. We do not agree. We believe the report contains the most important facts relevant to our objectives. Nonetheless, in response to DOD's comments, we did modify the report to provide some additional details on the results of the California Prioritization Protocol. However, we made no changes regarding the sources of perchlorate contamination in Massachusetts because this information was already included in our description of Massachusetts' actions to regulate perchlorate. We did not include information on the amount of perchlorate imported into the United States, the health risks of perchlorate, and the conclusions of the EPA Office of Inspector General's report, because these issues were beyond the scope of our report. For example, we were asked to report on what is known about the likely sources of perchlorate in the nation's water and food supply, not on the amount of perchlorate used for different purposes. Although an organization may use a significant amount of perchlorate for a specific purpose, the quantity used is not necessarily indicative of the amount of perchlorate released into the environment. Similarly, we were not asked to assess the public health risks of perchlorate exposure, so we did not address it in this report. Moreover, the scientific community is still debating health risk and, as we mentioned in the report, EPA has not yet made a final decision whether to set a regulatory standard for perchlorate in drinking water. DOD also provided technical comments, which we incorporated into the report as appropriate. DOD's comments and our detailed responses are presented in appendix IV of this report.

DOE and EPA did not provide formal comments. However, they provided technical comments by e-mail, which we incorporated as appropriate. NASA had no comments on the report.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the appropriate congressional committees, Secretaries of Defense and Energy, Administrators of the Environmental Protection Agency and National Aeronautics and Space Administration, and other interested parties. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or stephensonj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix V.

Sincerely yours,

John B. Stephenson
Director, Natural Resources
and Environment

Appendix I: Objectives, Scope, and Methodology

This report examines (1) what is known about the extent to which perchlorate occurs in the nation's water and food supply and its likely sources; (2) what actions the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the Department of Energy (DOE) have taken to respond to or lessen perchlorate releases; and (3) the actions states, such as California and Massachusetts, have taken to regulate perchlorate.

To determine what is known about the extent to which perchlorate occurs in the nation's water and food supply and its likely sources, we took a variety of actions.

- To determine what is known about the extent of perchlorate occurrence in the nation's public drinking water systems, we obtained and analyzed sampling data collected from 2001 through 2005 under EPA's Unregulated Contaminant Monitoring Rule 1. We assessed the procedure EPA used to collect the data by reviewing the statistical design, sample selection, and quality control methods used, and determined that the procedure was sufficiently reliable for the purposes of this report.

- To determine what is known about the extent of perchlorate occurrence in water and other media at DOD, NASA, and DOE installations and facilities, we obtained data on perchlorate occurrence at facilities owned or managed by these agencies. Specifically, at DOD, we obtained and analyzed data from their Perchlorate Survey Database for fiscal years 1997 through 2009. We assessed the reliability of the data for relevant variables by electronically testing for obvious errors in accuracy and completeness. We also reviewed information about the data and the systems that produced them and interviewed officials knowledgeable about the data. When we found inconsistencies in the data, we worked with the officials responsible for the data to clarify these inconsistencies before conducting our analyses. We determined that the data were sufficiently reliable for the purposes of reporting on perchlorate sampling and detections at the installations tracked by the database. We reviewed data provided by NASA and DOE on perchlorate detections reported by their facilities. We also interviewed officials from DOD, NASA, and DOE to determine that all data were reported.

- To determine what additional information existed on the extent of perchlorate occurrence in water, we obtained data from EPA on perchlorate occurrence at facilities on the National Priorities List—known as Superfund sites. We also reviewed perchlorate occurrence data provided by state environmental agencies in California, Massachusetts, Arizona, and Texas.

- To determine what is known about the extent of perchlorate occurrence in the nation's food supply, we performed a literature search to identify research on perchlorate occurrence in food. We reviewed the results of research conducted by the Food and Drug Administration (FDA), the U.S. Department of Agriculture, the Centers for Disease Control and Prevention, and academic researchers. We also interviewed officials from FDA, the U.S. Department of Agriculture, and EPA, as well as researchers at academic and private institutions, to identify what is known about the extent of perchlorate in the food supply, the relative source contributions, and any gaps in knowledge.

- To determine what is known about the likely sources of perchlorate, we reviewed research literature examining the different sources of man-made perchlorate and its uses, as well as the conditions under which perchlorate occurs naturally. We also interviewed EPA, U.S. Geological Survey, and state officials; researchers from a consortium of public, private, and academic entities developing an analytical method to determine the sources of perchlorate; and other stakeholders to obtain information on the history of perchlorate use, as well as developments in technology to determine the sources of known perchlorate occurrences.

To determine the actions DOD, NASA, and DOE have taken to respond to perchlorate releases, we reviewed and analyzed DOD data on perchlorate occurrence from DOD's Perchlorate Survey Database, DOD state summaries, NASA and DOE perchlorate occurrence data, EPA data on perchlorate occurrence at facilities on the National Priorities List, and state regulatory agency reports. We also obtained and reviewed documentation from federal and state agencies on the actions these three agencies have taken to respond to perchlorate releases and the status of these actions. We also interviewed agency officials and officials from state and other federal agencies to obtain information and their views on (1) the actions DOD, NASA, and DOE have taken to respond to perchlorate releases; (2) the status of these actions; and (3) whether these actions have lessened perchlorate releases. We visited the following DOD and NASA facilities to discuss and observe their activities related to perchlorate cleanup: Edwards Air Force Base (DOD), Redstone Army Arsenal (DOD), the Jet Propulsion Laboratory (NASA), and the Marshall Space Flight Center (NASA). We selected sites to visit that were identified by EPA, DOD, and NASA officials as illustrative of their perchlorate response actions. To determine the actions DOD, NASA, and DOE have taken to lessen perchlorate releases, we reviewed documents from agency officials and discussed current policies and practices they follow to lessen perchlorate releases. We also visited Aerojet, a private facility that

manufactures and tests rocket engines for the space and defense industries, to discuss and observe the operation of two types of perchlorate treatment facilities that are also being used by federal agencies.

To determine the actions California and Massachusetts have taken to regulate perchlorate, we reviewed state documents, such as perchlorate occurrence reports, risk assessments, and cost benefit analyses, and interviewed state officials. To determine the actions of other states to regulate perchlorate, we interviewed EPA regional officials and obtained information from the Association of State Drinking Water Administrators and identified states that have set advisory levels and cleanup goals for perchlorate. We interviewed environmental and public health officials from these states and obtained and reviewed documents related to perchlorate guidance for drinking water and groundwater.

Appendix II: National Priorities List Sites Where Perchlorate Has Been Identified as a Contaminant of Concern

State	Site name	Site type[a]
AL	Anniston Army Depot	DOD
AL	Redstone Arsenal (Army/NASA)	DOD
AZ	Apache Powder Company	Private
AZ	Phoenix Goodyear Airport Area, Unidynamics	Private
CA	Aerojet General Corp.	Private
CA	Casmalia Resources	Private
CA	Edwards Air Force Base, Air Force Research Laboratory	DOD
CA	Edwards Air Force Base, Jet Propulsion Laboratory	DOD
CA	El Toro Marine Corps Air Station	DOD
CA	Jet Propulsion Laboratory	NASA
CA	Lawrence Livermore National Laboratory Site 300	DOE
CA	Mather Air Force Base (former)	DOD
CA	McClellan Air Force Base (former)	DOD
CA	San Fernando Valley, Area 2-Glendale	Private
CA	San Gabriel Valley, Area 1-El Monte	Private
CA	San Gabriel Valley, Area 2-Baldwin Park	Private
CA	San Gabriel Valley, Area 4-Puente Valley	Private
CA	Stringfellow	Private
IL	Sangamo Electric Dump/Crab Orchard National Wildlife Refuge	DOI
MA	Fort Devens, South Post Impact Area	DOD
MA	Massachusetts Military Reservation	DOD
MD	Aberdeen Proving Ground	DOD
MD	Naval Surface Warfare Center–Indian Head	DOD
MD	Ordnance Products, Inc.	Private
MO	Lake City Army Ammunition Plant	DOD
NC	Chemtronics (aka Amcel Propulsion Inc.)	Private
NC	Marine Corps Air Station Cherry Point	DOD
NC	Marine Corps Base Camp Lejeune	DOD
NE	Nebraska Ordnance Plant (former)	Private
NJ	Picatinny Arsenal	DOD
NJ	Radiation Technology, Inc.	Private
NJ	Shieldalloy Corp.	Private
OR	Portland Harbor	Private
OR	Umatilla Ammunition Demolition Area	DOD
TN	Milan Army Ammunition Plant	DOD
TX	Longhorn Army Ammunition Plant	DOD

State	Site name	Site type[a]
TX	Pantex Plant	DOE
UT	Hill Air Force Base	DOD
VA	Naval Surface Warfare Center-Dahlgren	DOD
WV	Allegheny Ballistics Laboratory, Alliant Techsystems, Inc.	DOD

Source: EPA.

Notes: The term “site” refers to the physical location where perchlorate was found.

According to EPA, additional National Priorities List sites may have perchlorate at some level. However, EPA does not currently have enough information to determine whether perchlorate is a contaminant of concern at those sites.

[a]"Site type” includes private sites and those at federal facilities, including the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), and the Department of the Interior (DOI).

Appendix III: Actions Taken by DOD at Installations with Perchlorate Detections above 15 Parts per Billion

State	Installation	Service	Installation type	Media	Highest detection (ppb)	Action[a]
AL	Anniston Army Depot	Army	Active	Groundwater	31.2	Ongoing monitoring
AL	Redstone Arsenal	Army	Active	Groundwater Soil Surface water	2,600,000 38 250	Risk assessment under way
AR	Pine Bluff Arsenal	Army	Active	Groundwater	500	Ongoing monitoring
AZ	Barry M. Goldwater Range	Air Force	Active	Soil	1,400	No action needed based on consultation with regulators
AZ	Yuma Marine Corps Air Station	Marine Corps	Active	Soil	786,000	Ongoing monitoring
CA	Beale Air Force Base	Air Force	Active	Groundwater	130	Remediation under way
CA	China Lake Naval Air Weapons Station	Navy	Active	Groundwater	720	No action needed based on completed risk assessment
CA	Edwards Air Force Base	Air Force	Active	Groundwater	7,700	Risk assessment completed and remediation under way
CA	El Centro Naval Air Facility	Navy	Active	Soil	43	No action needed
CA	El Toro Marine Corps Air Station (former)	Marine Corps	BRAC[b]	Groundwater Soil	710 1,600	Risk assessment under way and bioremediation pilot study planned
CA	McClellan Air Force Base (former)	Air Force	BRAC	Groundwater	95	Risk assessment completed Ongoing monitoring Remediation under way
CA	Morris Dam Naval Command, Control and Ocean Surveillance Center	Navy	Non-BRAC closed	Groundwater Soil	65 754	Risk assessment completed and remediation planned
CA	San Nicolas Island Naval Outlying Field	Navy	Active	Soil Surface water Wastewater	192,570 3,000 30	Range assessment under way
CA	Seal Beach Naval Weapons Station	Navy	Active	Other	9,410	Risk assessment under way
CA	Seal Beach Naval Weapons Station–Detachment Fallbrook	Navy	Active	Soil	18	No action needed
CA	Vandenberg Air Force Base	Air Force	Active	Groundwater Surface water	337 65	Remediation pilot study under way
DC	Spring Valley-formerly used defense site	Army	Non-BRAC closed	Groundwater	146	Risk assessment under way Ongoing monitoring
FL	Eglin Air Force Base	Air Force	Active	Groundwater	27	No action taken because munitions containing perchlorate were removed

State	Installation	Service	Installation type	Media	Highest detection (ppb)	Action[a]
ID	Mountain Home Air Force Base	Air Force	Active	Soil	20	Remediation complete with removal of contaminated soil and site closure
IN	Crane Division, Naval Surface Warfare Center	Navy	Active	Groundwater Soil Wastewater	67 470 356	Ongoing monitoring planned for groundwater and soil
MA	Camp Edwards/ Massachusetts Military Reservation	Army/Air Force	Active	Groundwater Soil	770 8,060	Remediation under way
MA	Fort Devens	Army	Active	Groundwater	133	Ongoing monitoring
MD	Aberdeen Proving Ground	Army	Active	Groundwater	140	Ongoing monitoring
MD	Indian Head Naval Surface Facility	Navy	Active	Groundwater Sediment Soil Surface water Wastewater	276,000 230 480,000 190 9,500	Planned action for groundwater under separate program because site is an active range Remediation planned for sediment and soil Ongoing monitoring for wastewater
MD	White Oak Naval Surface Warfare Center (former)	Navy	BRAC	Groundwater Soil	880 1,400	Remediation under way
MI	Camp Grayling	Army	Active	Groundwater	17.7	Risk assessment planned
MO	Lake City Army Ammunition Plant	Army	Active	Groundwater	78	Ongoing monitoring
MO	Whiteman Air Force Base	Air Force	Active	Groundwater	130	Risk assessment completed No further action required
NC	Camp Lejeune Marine Corps Base/New River Marine Corps Air Station	Marine Corps	Active	Soil	350	Risk assessment under way
NC	Cherry Point Marine Corps Air Station	Marine Corps	Active	Groundwater Soil	179 16	Risk assessment completed Remediation planned
NJ	Earle Naval Weapons Center	Navy	Active	Groundwater Soil	398 87	Ongoing monitoring
NM	Cannon Air Force Base	Air Force	Active	Groundwater	46	Ongoing monitoring
NM	Fort Wingate	Army	BRAC	Groundwater	240	Remediation plannedc
NM	Holloman Air Force Base	Air Force	Active	Groundwater	190	Risk assessment planned
NM	Kirtland Air Force Base	Air Force	Active	Groundwater	16	Risk assessment under way
NM	White Sands Missile Range	Army	Active	Groundwater	6,700	Remediation under way and pilot study
OK	McAlester Army Ammunition Plant	Army	Active	Groundwater	23	Ongoing monitoring

State	Installation	Service	Installation type	Media	Highest detection (ppb)	Action[a]
OK	Tinker Air Force Base	Air Force	Active	Soil	5,580	No action neededc
SC	Beaufort Marine Corps Air Station	Marine Corps	Active	Groundwater	18.2	Ongoing monitoring
SC	Shaw Air Force Base	Air Force	Active	Groundwater	27.9	Ongoing monitoring Land use control
SD	Rapid City Small Arms Range Annex	Army	Transferred	Soil	70.3	Risk assessment planned
TN	Arnold Air Force Base	Air Force	Active	Groundwater	830	Risk assessment completed Remediation pilot study under way
TN	Milan Army Ammunition Plant	Army	Active	Groundwater Soil	25.4 1,400	Risk assessment under way
TX	Camp Bullis	Army	Active	Groundwater	174	Risk assessment under way Ongoing monitoring
TX	Longhorn Army Ammunition Plant	Army	Transferred	Groundwater Other Sediment Soil Surface water	360,000 23,000 172 572,000 122	Remediation under way
TX	McGregor Naval Weapons Industrial Reserve Plant	Navy	Transferred	Groundwater Soil Surface water	91,000 1,800 6,600	Remediation completed
TX	Red River Army Depot	Army	Active	Groundwater Other	37.4 252	Ongoing monitoring
UT	Hill Air Force Base	Air Force	Active	Groundwater Soil	39.9 86,000	Ongoing monitoring
VA	Dahlgren Naval Surface Facility	Navy	Active	Groundwater Sediment Soil Surface water	2,700 120 3,100 230	Risk assessment under way
VA	Radford Army Ammunition Plant	Army	Active	Groundwater	127	Ongoing monitoring Planned action based on permit modification
VA	Yorktown Naval Weapons Station	Navy	Active	Groundwater	160	Ongoing monitoring Risk assessment under way
WA	Camp Bonneville	Army	Transferred	Groundwater	490	Contaminated soil removed Ongoing monitoring
WV	Allegany Ballistics Laboratory	Navy	Active	Groundwater Soil Surface water Wastewater	34,900 35,000 690 1,900,000	Remediation planned Remediation planned Groundwater source suspected Remediation under way

Sources: GAO analysis of EPA and DOD data.

Notes: DOD officials said that these data do not represent a comprehensive list of actions DOD has taken in response to perchlorate releases because the database only has information on cleanup activities at installations where perchlorate is a primary contaminant of concern.

According to DOD officials, EPA regions and states typically set higher screening levels for perchlorate in soil. Therefore, DOD's 15 parts per billion screening level is not applicable to soil.

[a]Ongoing monitoring means monitoring that occurs on a regular basis; "risk assessment" includes both site investigations and risk assessments; "consultation with regulators" means discussions between installation officials and EPA or state regulators regarding the actions needed to clean up perchlorate.

[b]BRAC means Base Realignment and Closure and describes an installation that has been closed as part of the process to realign the military infrastructure to match the size of the military in terms of personnel and equipment.

[c]According to DOD officials, in March 2003, perchlorate was detected in a soil sample at 5,580 parts per billion using EPA Method 314.0, but additional samples taken in 2009 using EPA Method 6850 did not detect perchlorate above the method detection limit. Consultation with state regulators resulted in agreement that the initial detection of 5,580 parts per billion was likely attributable to the misapplication of EPA Method 314.0 to soil samples and that, because of the 2009 sampling results, no action is required, DOD officials said.

Appendix IV: Comments from the Department of Defense

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

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ACQUISITION,
TECHNOLOGY
AND LOGISTICS

JUL 26 2010

Mr. John B. Stephenson
Director, Director, Natural Resources
and Environment
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Mr. Stephenson:

This is the Department of Defense (DoD) response to the GAO Draft Report GAO-10-769, "PERCHLORATE: Occurrence is Widespread but at Varying Levels; Federal Agencies Have Taken Some Actions to Respond to and Lessen Releases," dated July 6, 2010 (GAO Code 361105).

The Department believes that the GAO report omitted a number of important facts and conclusions resulting from state and DoD initiatives. Although GAO made no recommendations in this report, we believe the enclosed comments will help provide additional perspective and ensure that the Congress and the public better understand the risks related to perchlorate and DoD actions taken to ensure protection of human health and the environment.

Sincerely,

John Conger

John Conger
Assistant Deputy Under Secretary of Defense
(Installations and Environment)

Enclosure:
As stated

GAO Draft Report Dated July 2010
GAO-10-769 (GAO CODE 361105)

"PERCHLORATE: OCCURRENCE IS WIDESPREAD BUT AT VARYING LEVELS; FEDERAL AGENCIES HAVE TAKEN SOME ACTIONS TO RESPOND TO AND LESSEN RELEASES"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO REPORT

Major Issues:

See comment 1.

1. The report mentions the California Prioritization Protocol, a collaborative effort between the State and DoD, but fails to provide the major conclusions from over two years of effort.

As a result of concern over widespread perchlorate contamination in California, DoD and California regulators collaboratively developed a screening procedure for DoD sites called the California Perchlorate Prioritization Protocol. Using the protocol, DoD and the California Department of Toxic Substances Control and the State Water Resources Control Board screened 924 DoD sites that had the *potential* for perchlorate releases. No risks to public water supplies were identified.

A December 2008 Environmental Management article jointly written by DoD and California regulatory personnel, states that the "protocol, when taken together with other DoD sampling and remedial efforts, as well as sampling efforts by other parties, reveals that the sources of perchlorate detections in water wells appears to be far more complicated than originally suspected. Based on the results of the prioritization, the current regulatory standards for perchlorate, sampling results to date, as well as actions taken to manage new releases and remediate known perchlorate releases, it appears that DoD installations/FUDS are not significantly impacting California public drinking water wells."

See comment 2.

2. The report mentions that Massachusetts found perchlorate in nine of 600 water systems tested but fails to mention that none of these detections were related to military sources. The report also fails to describe the perchlorate sources that were determined by the State.

1

In a March 14, 2005 letter to EPA Assistant Administrator Ben Grumbles, Mr. Robert Golledge, Commissioner, Massachusetts Department of Environmental Protection stated the following:

> "In March 2004, the Department initiated the process to establish a drinking water maximum contaminant level (MCL) for perchlorate by promulgating regulations requiring all public water supplies to test for perchlorate. Several rounds of sampling have been completed statewide. Nine public water supplies have detected perchlorate, seven of the nine have perchlorate ranging from just below 1 ppb to slightly above 3 ppb. However, two water supplies had greater than 45 ppb, one as high as 1300 ppb. When confronted with the perchlorate plume at Massachusetts Military Reservation in 2001, most thought the primary source of perchlorate contamination was the result of military training activities. None of the nine water supplies that have tested positive for perchlorate in Massachusetts appear to have any connection to military bases or activities."

The report states that Massachusetts officials were able to "determine the localized sources of high concentrations of perchlorate" but does not identify those sources. An example of a source identified by the state is blasting activities from road construction.

See comment 3.

3. The report fails to mention Department of Commerce data, provided to GAO by DoD, describing the large amount of perchlorate imported into the U.S. primarily for fireworks and used in an uncontrolled manner over large areas.

This data provides perspective on DoD's use versus imports for commercial use. According to the American Pyrotechnics Association, 278.2 million pounds of fireworks were consumed in the U.S. annually over a recent 5 year period, approximately 14 million pounds of which is perchlorate.

DoD purchases of perchlorate compounds in weapon systems was between 6 - 8 million pounds over a similar 5 year period. Much of this perchlorate is stored in missiles and munitions or used in overseas combat areas.

See comment 4.

4. By leaving out various factors, the report's review of historical sampling data leads the reader to believe that the public health risk of perchlorate from DoD activities is greater than it actually is.

See comment 5.

First, when identifying samples that exceeded screening levels, the report did not note those detections that have since been remediated or assessed as requiring no further action. Such sites present no risk. Thus, by reporting all historical detections with no explanation, the report makes it appear that all detections present a risk.

See comment 6.

Second, the report identifies all DoD perchlorate samples over 15 ppb regardless of whether the sample was taken from drinking water or soil. EPA's Public Health Advisory screening level for drinking water is 15 ppb. EPA Regions and states typically set much higher risk screening levels for soils. For example, a widely-used EPA Regional Screening Level for perchlorate in soil is 55 mg/kg or 55,000 ppb. By citing soil samples with perchlorate levels above the screening level for drinking water, the report inflates the appearance of risk to public health.

See comment 7.

Third, the report does not take into account other risk factors. Screening levels are only a starting point. Risk is determined more definitively through a baseline human health risk assessment.

See comment 8.

Fourth, the report does not offer an overall perspective of the DoD sample results or a full understanding of risk. Based on DoD risk assessments and over 50,000 samples taken at or around DoD installations in the U.S., DoD believes that there are no DoD releases of perchlorate currently presenting a human health threat to public drinking water supplies.

See comment 9.

Finally, the report does not take into account DoD efforts to verify the conclusions we have reached from our sampling program with state and federal regulators. For example, in an April 2009 letter to EPA's Director of the Federal Facilities Restoration and Reuse office, DoD stated: "Based on our data and discussion with the Military Services, we believe that appropriate actions are being taken, in consultation with regulators, at all sites with releases." The letter further states: "We want to ensure that there are no DoD releases of perchlorate that would cause an exposure in current drinking water at levels above a state MCL or the EPA Health Advisory Level of 15 ppb. Based on information and data currently available, we do not believe any of our installations or FUDS are in this category at this time. The main purpose of this letter is to determine if you agree with this characterization and whether you have any additional information that would help inform our characterization."

After consultation with EPA Regions and EPA program offices, EPA's Director of the Federal Facilities Restoration and Reuse office replied in a March 2010 letter. Because EPA did not have data from all possible sites, EPA could not confirm whether or not there have been releases of perchlorate from DoD-owned facilities that resulted in exposure in drinking water at levels above a state standard or the Interim Health Advisory Level for perchlorate of 15 ppb. However, the letter states: "My office is unaware of information reported to EPA that would indicate such releases."

See comment 10.

In summary, by not taking into account all the factors associated with the DoD perchlorate sampling program, the report leads the reader to believe that the public health risk of perchlorate from DoD activities is greater than it is.

3

See comment 11.

5. The report fails to provide the conclusions of the EPA Office of Inspector General's report on perchlorate. The conclusions are significant to understanding perchlorate risks and risk management options.

The EPA Office of Inspector General's (OIG) Report "Scientific Analysis of Perchlorate", Report No. 10-P-0101, April 19, 2010, has significant findings that GAO fails to provide. The GAO report simply states that the EPA OIG "released a report that reviewed and critiqued the risk assessment process and procedures used by EPA to develop and derive a perchlorate reference dose".

The conclusions of the EPA OIG report were:

"Based on our scientific analysis, perchlorate is only one of several chemicals that stress the thyroid's ability to uptake iodide. The other sodium iodide symporter (NIS) stressors include thiocyanate, nitrate, and the lack of iodide. All four of these NIS stressors meet EPA's risk assessment guidance for conducting a cumulative risk assessment using the dose-addition method. Our analysis implemented a cumulative risk assessment that found the following: 1) the risk from each of the four NIS stressors is not equal; 2) EPA's perchlorate RfD is conservative and protective of human health, and further reducing the perchlorate exposure below the RfD does not effectively lower risk; 3) increasing maternal total iodide intake to healthy levels will reduce the frequency and severity of permanent mental deficits in children; and 4) correcting moderate and mild iodide deficiency occurring in about 29 percent of the U.S. pregnant and nursing population is the most effective approach for reducing risk."

Additional Comments.

See comment 12.

Title Page - In the title, the use of the term "Some" is misleading. DoD believes it demonstrated to GAO that appropriate actions are being taken at *all* installations in coordination with regulators. The term "Some" does not accurately reflect the scope and completeness of the DoD sampling, assessment, and remediation actions.

Executive Summary and Page 11-12 states: "DoD reported perchlorate detections at 284 of its installations, or almost 70 percent of the 407 installations sampled from fiscal years 1997 through 2009...."

See comment 13.

At low levels, perchlorate can be found almost everywhere. The report overstates the situation by essentially equating every detection greater than absolute zero as a detection of significance.

See comment 14. Page numbers in the draft report may differ from those in this report.

Page 3: The report fails to mention the use of sodium hypochlorite in home septic systems and wastewater treatment plants as a source of perchlorate in drinking water.

4

The State of Massachusetts' study, cited in the GAO report, identified home septic systems as such a source.

Page 16: The report could have identified other means by which perchlorate may enter the food chain other than through contact with contaminated water. Atmospheric deposition and photosynthesis in areas with high ground ozone are also suspected sources and are being researched.

See comment 15.

Page 20: From the manner by which the report presents DoD's sampling information, the reader could draw the conclusion that 137 installations (361 minus 224) did not sample and had no explanation for not sampling. This conclusion is not correct. The report inappropriately excludes data that exists only in textual narrative form (e.g., Air Force and Army documentation prior to 2007 is captured in DoD's data base as text rather than as an MS Excel data field). DoD has sampled at all installations where there have been releases or suspected releases of perchlorate.

See comment 16.

Page 22: Regarding *Redstone Arsenal. In lieu of GAO's summary, it would be more correct to state:* "The Army has identified and planned a number of soil removal actions to remove contaminated soils that serve as an on-going source of perchlorate to groundwater. The Army is drafting a memorandum of understanding (MOU) with the City of Huntsville whereby the City will consult with the Army before approving any well installation requests for areas with the potential for perchlorate contamination." GAO stated that "EPA officials told us that the current cleanup documentation provided to the regulatory agencies indicates that he Army does not intend to remediate perchlorate in groundwater at Redstone." However, the Army is in the process of obtaining regulatory approval for further site investigation on some perchlorate contaminated areas. The investigations could determine the need for and feasibility of remedial action.

See comment 17.

Page 24 - GAO has oversimplified and unintentionally mischaracterized the Kirtland AFB issue. The New Mexico Environmental Department (NMED) has attempted to enforce a 4 ppb perchlorate standard on its permittees despite no promulgated regulatory standard. Kirtland AFB formally notified the NMED Groundwater Quality Bureau of perchlorate detection in a letter from the Base Commander dated 1 March 2005. It was not until 23 June 2009, however, that NMED Hazardous Waste Bureau issued a letter to Kirtland AFB to begin investigation/cleanup of the perchlorate at the site. GAO's draft report currently states: "According to the Air Force, it is discussing with New Mexico regulators whether cleanup should be conducted under CERCLA or the state's RCRA authority". It is more accurate to say: "On-going legal discussions continue in order to resolve a disagreement over whether further actions should be conducted under CERCLA pursuant to the DoD perchlorate policy, or under the state's RCRA authority. In the meantime, the Air Force has submitted a Site Investigation Work Plan to the state and has begun investigating the site; no pathway to public or private drinking water sources has been demonstrated to date."

5

See comment 18.

Page 44, Appendix II - Mather and McClellan AFBs are closed BRAC bases and should be referred to as Former Mather and Former McClellan AFBs.

Page 46: Appendix III.

See comment 19.

Camp Edwards/MMR should be attributed to both Air Force and Army.

See comment 20.

The appendix lists McAlester Ammunition Plant, OK, as having remediation underway, and indicates groundwater remediation – this is not correct. McAlester has ongoing monitoring for perchlorate in groundwater. McAlester has an effluent treatment system for perchlorate for its perchlorate loading and packing operations.

See comment 20.

Under the Action column for China Lake Naval Air Weapons Station, it would be more correct to indicate that remediation is unnecessary based on risk assessment results.

See comment 20.

The Action column for El Centro Naval Air Facility should indicate that the 15 ppb PRG is not applicable to soil.

See comment 20.

The Action column for NOLF San Nicolas Island should indicate that a Range Condition Assessment is underway.

See comment 20.

The Action column for NWS Seal Beach Detachment Fallbrook should indicate that the 15 ppb PRG is not applicable to soil.

6

The following are GAO's comments on the Department of Defense's letter dated July 26, 2010, and provided by the Assistant Under Secretary of Defense (Installations and Environment).

GAO Comments

1. We revised the text to provide some additional detail about the California Prioritization Protocol.

2. We disagree with DOD's comment that, while the report mentions the results of perchlorate sampling in Massachusetts, it fails to mention that none of these detections were related to military sources and to describe the perchlorate sources that were determined by the state. This information appears on page 31 in the section of the report describing Massachusetts' actions to regulate perchlorate.

3. Information on the amount of perchlorate imported primarily for fireworks compared with the amount of perchlorate used by DOD is beyond the scope of this report, which focuses on the extent and likely sources of perchlorate occurrence, and federal agency actions to respond to and lessen releases. Although an organization may use a significant amount of perchlorate for a specific purpose, the quantity used is not necessarily indicative of the amount of perchlorate released into the environment.

4. A discussion of the public health risks of perchlorate is beyond the scope of this report. The scientific community is still debating health risks associated with perchlorate.

5. Appendix III describes the actions DOD has taken to respond to perchlorate releases and notes when DOD's assessment concluded that no further action is required.

6. We revised appendix III to note that DOD does not apply the 15 parts per billion screening level to soil.

7. A discussion of the public health risks of perchlorate is beyond the scope of this report.

8. This report draws no conclusions regarding the human health threat that DOD releases of perchlorate currently pose to public drinking water supplies because it is beyond the scope of our work.

9. A discussion of DOD's efforts to verify the conclusions from its sampling program with state and federal regulators is beyond the scope of our report.

10. A discussion of the public health risks of perchlorate is beyond the scope of this report.

11. Because a discussion of the public health risks of perchlorate is beyond the scope of this report, we did not evaluate or report on the conclusions of the Inspector General's report in this regard.

12. We disagree with DOD's comment that our title is misleading. DOD is only one of three federal agencies whose actions we describe in the report and, therefore, we believe that the title is appropriate.

13. The report does not characterize the significance of detections. Rather, we note the range of detections at DOD installations and the number of installations with detections above 15 parts per billion—DOD's current threshold level for conducting further investigation when perchlorate is detected in water to determine whether additional action is warranted.

14. The report mentions that sodium hypochlorite solutions used as a disinfectant in water and water treatment plants is a source of perchlorate. See pages 2 and 32.

15. We revised the text to clarify the DOD sampling information presented in the report, which includes the results of GAO's analysis of data that exists only in narrative format.

16. We revised the text to include the Army's description of actions taken at Redstone Arsenal.

17. We revised the text to clarify the Air Force's position on the status of actions being taken to respond to perchlorate at Kirtland Air Force Base.

18. We revised appendix II to show that Mather and McClellan Air Force Bases are closed.

19. We revised appendix III to attribute Camp Edwards/Massachusetts Military Reservation to both the Air Force and the Army.

20. In appendix III, we revised the action column for McAlester Ammunition Plant, China Lake Naval Air Weapons Station, El Centro Naval Air Facility, NOLF San Nicolas Island, and NWS Seal Beach Detachment Fallbrook to reflect the information provided by DOD.

Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

John B. Stephenson, (202) 512-3841, or stephensonj@gao.gov.

Staff Acknowledgments

In addition to the individual named above, Stephen Secrist, Assistant Director; Elizabeth Beardsley; Mark Braza; N'Kenge Gibson; Mitchell Karpman; Susan Malone; Madhav Panwar; Jeremy Sebest; Ben Shouse; Matthew Tabbert; and Kiki Theodoropoulos made key contributions to this report.

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